SCIENTIFIC AMERICAN SUPPLEMENT. No 1418

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Scientific American, established 1845.
Scientific American Supplement, Vol. LV. No. 1418.

NEW YORK, MARCH 7, 1903.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

HARBOR OFFICE AND CUSTOM HOUSE.—DRAWN BY MR. H. W. BREWER.

HARBOR OFFICE AND CUSTOM HOUSE.

In this composition I have attempted to show how commercial buildings can be invested with picturesqueness. Before the age of modernization set in, there were many Flemish towns in which the buildings devoted to trade were conspicuous for their beauty. The divorce between business and art in the realm of architecture is of recent origin. There is no necessary antagonism between picturesqueness and utility; even such structures as the warehouse and the crane can be made pleasing to the sight; indeed, Pugin somewhere says that the railway station affords opportunities for architectural display excelled only by the cathedral. Unfortunately, the modern "practical man" thinks that when artistic design is considered, utility must be sacrificed; and this erroneous idea, more even, perhaps, than lack of taste, is responsible for the hideousness of so many of our commercial buildings.—H. W. Brewer, in the Builder.

ALUMINOGRAPHY.

Aluminium is, incontestably, one of the most interesting bodies which chemical investigation has disclosed to modern industry. Great hopes were placed in this metal. Many have not been realized, but on the other hand unthought of applications were found for this body, thus opening new fields of industry. Aluminium is found all over the earth, although never in a pure state like gold and silver, but in combination with oxygen, the alkalies, silicium, etc. It occurs most frequently as the metallic constituent of alumina, for which reason the latter is now exclusively employed for the production of aluminium.

In the rolled state, aluminium has a specific gravity of 2.70, hence it is three to four times as light as zinc or copper, and possesses very remarkable properties. If suitably kept, it shows no tendency to oxidize, excelling in this respect all base metals. Its color is a silver gray; it is quickly dissolved by hydrochloric acid and alkaline lyes; sulphuric acid attacks it but slowly; nitric acid not at all. It has great affinity for fats, and enters with phosphoric acid into a combination upon which is based its utilizability as a printing plate. It is used for flat printing, that is to say, the impressing surface is neither raised nor sunken on the printing material; hence its theory is founded upon the same principles as lithography, which is governed essentially by the opposite qualities of fat and water. Aluminium has affinity for both, but does not allow the water where the fat is, and *vice versa*. Hence it permits of taking many equivalent impressions of writing or drawing made upon it by means of fat followed by a treatment with phosphated gum solution. In this respect aluminium is perfectly analogous to the lithographic stone, but while with the latter the drawing consists of a chemically-changed substance—sebate of lime—which enters the stone more or less deeply, the fat-attracting substance adheres but superficially to the aluminium, without penetrating the metal and changing it. This also explains the fact that the plates are rendered serviceable again for renewed use, by a simple treatment with an acid bath, without losing in weight, while the weight of the stone is considerably decreased every time by the required grinding off.

The effort to find a substitute for the lithographic stone, known as a reliable agent, is justified when we consider that this stone, outside of its excellent printing qualities, possesses only unpleasant properties very awkward for the owners of printing establishments, such as great fragility, dissimilarity of quality, with high prices, so that it is very difficult nowadays to obtain the large sizes required. The stone also requires great forces and contrivances for transportation inside as well as outside of the shops, as well as much space for storing. Aluminium rolled out into thin plates lasts as long as stones 3 inches thick, while the cost for medium-sized plates of the same is 75 per cent. less. The greatest advantage, however, lies probably in the slight weight of the plates, which renders the work in printing shops easier, simpler, and more convenient than with the use of stones. The square foot of a lithographic stone, 3 inches thick, weighs 30.78 pounds, while a similar plate of aluminium weighs only 2.2 pounds. It is therefore only natural that the process to print from aluminium has met with a favorable reception and that its use is constantly increasing.

The process to cover aluminium plates with a water-attracting layer for flat printing consists in treating the drawing or writing on the plate with phosphated gum solution; in other words, the patent is obtained for etching on aluminium by means of phosphoric acid. This acid is absolutely necessary to start the process and to obtain good results, which are not attained with the use of other acids. Only through treatment with phosphated gum solution, aluminium obtains the so-called insoluble coating of a pasty, hygroscopic body, necessary for flat printing, which, readily absorbing the moisture, prohibits the taking up of fats.

The aluminium plates are furnished smooth, or with fine, medium, or coarse grain. A coarse graining, however, is not commendable for plates which are to be reprinted, but only for large works, which are printed direct from the original plates. The plates should lie perfectly flat and show no holes or cracks. The corners must be rounded off and the edges smoothed down thoroughly with the file. A well-rolled plate is silver white in color and as smooth as a mirror. To print aluminium plates in the fast printing press, they must be mounted on an underlay, which makes it necessary to order the plates in a larger width. In order to ascertain the exact size quickly, take the measure of the printing surface of the stanchion serving as support and add 2.5 inches for inserting and turning over the edges. This allowance is the same for all fast printing machines, large or small.

For color printing in the fast press, it is absolutely necessary that the inking rollers be covered with rubber instead of leather. The customary smooth leather rollers for chromatic printing soon polish the aluminium, the water is not properly distributed on the plate, and the drawing loses its force and consequently its durability. Moreover, the leather rollers carry many grains of sand and other bodies which drop into the rollers when the paper is inserted, and scratch the plate.

Special directions regarding the equipment for aluminium printing cannot be given here, since the conditions and space at disposal vary everywhere. Cleanliness and warmth are essential for the success of the process; hence a uniform temperature, not below 15 degrees Reaumur (65 degrees F.) should be provided in the workrooms. Hot weather is no impediment.

For re-impressions a large amount of warm water must always be at hand, summer or winter; several lath stands in which the bathed, ground, and reprinted plates can stand without touching each other, should be put up. Above or alongside of the grinding table should be a hydrant with rubber hose and a free drain underneath. The acid bath is put in an open airy place (courtyard) but must be protected from great heat or cold. The rinsing and cleaning of the plates from the acid bath is also best accomplished in the yard by means of a jet of water.

The object of the acid bath is to clean the aluminium; it consists of one part of nitric acid free from chlorine and 3 parts of water. The mixture need not be scrupulously measured out; it suffices to fill a clay vessel to be used for this purpose three quarters full of water, adding nitric acid, free from chlorine, until the receptacle is filled up. The bath retains its full efficacy, despite daily use, for a long time, at least one-half year, and has then only to be regenerated with a few liters of nitric acid. Should dirt accumulate at the surface through long use, pour in two or three liters (a liter is a little less than a quart) of sulphuric acid, stir up well from the bottom, and take off the dirt on the surface by means of a wisp of straw.

The bath must not come in contact with any other metal than aluminium, for which reason the tongs used for putting in and taking out the plates and the combs must also be of aluminium.

The plate cleaned in the bath is rubbed down with powdered pumice-stone, and felt. This is no grinding, but merely a roughening of the plate, so that, on the one hand, the fat of the design or the re-impression can obtain a better support, and, on the other hand, a more favorable foundation is given to the subsequent preparation than with polished plates. When the plate is nice and even, water is poured on and the aforementioned powdered pumice stone is sifted on and, after saturating a felt scrubber with water, the whole plate is rubbed down with it, always in a circular motion and with considerable pressure. The pumice stone powder should never be used until a blackish mud results, but fresh powder should be sifted on twice or three times.

Aluminium cannot be grained like the stone, therefore the sand blast was at first used for that purpose, but now this method has been discarded, since special machines have been built in which the aluminium plates can be grained as well as ground smooth. When the plate has been grained, it is placed in the acid bath to eliminate the grains of sand which have entered, next it is rinsed off thoroughly and rubbed down again another ten minutes with vitreous sand and felt scrubber, then once more rinsed off and dried over a hot place if possible.

The grinding with powdered pumice stone in a small hand-box is not advisable, but, on the other hand, it is very commendable to perform this work in the shaking machine if the plates are good-sized. It is self-understood that no more sand must be in the box, as the grinding has to be done with pumice stone powder, and instead of glass balls, wooden balls should be used. The grinding of a box full of plates requires thirty to forty minutes. It is advisable not to grind or grain a larger number of plates than will be used the next following days, or else to rub down again by hand such plates that have been prepared a long time before use.

The drawing on aluminium plates (algraphy) offers no difficulties to the artist; a skilled lithographer, after a little practice, works just as easily and quickly on it as on stone. All styles of lithography, except engraving, are applicable on aluminium, and here, the same as in drawing on stone, it is the skill of the designer only upon which the work depends. A rather appreciable disadvantage of the aluminium plates lies in the fact that they cannot be worked as easily as the stone with scraper and needle. Nevertheless, if these tools are skillfully handled, some good results can be obtained, although as a general rule it is preferable to arrange the work in such a manner that scraping and cutting with the needle during the designing are avoided. Major corrections are attended to after the first impressions have been taken; they can then be readily performed, while this is impossible with the stone. During the work extreme care must be taken to guard against soiling the plate with grease, e. g., with finger-marks, since the methods of cleansing by scraping and etching pursued in the use of stone can be carried out only to a very limited extent.

For sketching or tracing, use only very soft lead pencil or chalk; for large work, charcoal. Direct pounces must be made of paper free from grease; for intermediate pounces a red-chalk sheet should be employed. Scratched gelatine tracings, rubbed with finely powdered red chalk and milori blue, can be transferred dry to the plate. A change of temperature does not spoil the work, as is often the case with stone drawings.

For the production of printable designs the same material should be employed as in lithography, that is to say, lithographic chalk and India ink, as they are found in commerce and adapted to the desires and work of the artist. In drawing and dotting with the pen, care should be taken that the pen does not scratch and the ink is fat and rich when it reaches the plate.

For combination pen and chalk work do not use too soft India ink. In redrawing it clings to the point of the chalk, which causes the ink surface to become dull and the chalk portions to blur. Squirt work, whether produced by means of air brush or ordinary brush or any other instrument, is well adapted for use on aluminium, if executed with skill and not too close. Similarly as on stone, acid mucilage may be used here for stopping-off, before or during the work, to attain the most varying gradations of tone.

Outside of the usual styles, a sort of half-tone drawing in the style of a wash can be executed on aluminium by means of brush and thin India ink. In order to produce such washed drawings, the ink is ground dry in a flat dish and dissolved rather thin with milk, rubbing with a cork stopper; thicker ink, however, should be left to remain at the edge of the dish. A second dish with a little milk serves for diluting to lay out the light tones, the method being the same as for aquareling on paper; the aluminium plate should have a medium grain. After laying on the first light tones, it is well to go over them with a soft leather rag, before putting in further tones. The finished ink drawing is talcumed well, sprinkled with very fine graining sand, and rubbed lightly in a circular motion, with a linen wad, until the drawings are slightly deadened. Dust off the work thoroughly with a brush to remove the sand, rub the plate again with talcum, and etch. These drawings should be washed out sharply with turpentine before printing, and should be printed with a fine grain leather roller. This style is not suited for re-impression or for printing on fast presses, but only for artistic printing.

Finally it should be mentioned that a lead pencil drawing executed on aluminium can be printed although, it is true, such an original drawing does not admit of more than about one hundred impressions. The copies always make, when printed in a suitable color, a very good impression, and look much like the original. For this purpose the aluminium plate has to be etched previous to drawing on it. The etching liquid is wiped off thoroughly with a rag and then the plate is dried. Now the drawing can be made in prominent lines with a hard lead pencil, No. 5 or 6 H. Faint lines which do not penetrate through the etching layer will not be visible in the print. After completing the design, the plate is coated with a fixative, dried, rinsed off with water, rolled in, and gummed, after which it is ready for printing.

For the preparation of the aluminium etching agent, ortho-phosphoric acid of sirupy consistency is used. To render it more suitable for the mixture, it is diluted with water to 20 per cent, which has to be accurately measured by means of a hydrometer. The gum solution is the customary one in printing establishments, generally 50 grammes of gum to 500 cubic centimeters of water. This solution should be poured through a fine sieve and all residues removed. To 10 parts of the gum solution add 1 part of 20 per cent phosphoric acid, shake the whole together well and add a few drops of red ink for coloring to avoid mistaking it for pure gum or other preparations. The etching liquid should be prepared if possible a day before use; for faint drawings it may be diluted with gum. To make the drawing ready for etching, the original plate is heated slightly and rubbed with talcum, the result being that the India ink and chalk do not easily dissolve and blur when applying the etching agent.

For printing black or deep-colored grain drawings, leather rollers should be employed; in all other cases preference should be given to a rubber cylinder. For wiping grain plates a sponge is required, for smooth plates fine nettle cloth or molton. Printing from small original plates is generally started in the hand press (any lithographic press is suitable); for a support a smoothly ground stone or iron fundament without any stretching contrivance is used, since the sizes change continually. The strictest cleanliness must be observed between plate and support, since every grain of sand, even cotton threads, will, during the printing, be pressed into the metal, thus causing an elevation on the face of the plate, which readily takes up ink. In order to produce a sufficiently solid connection between plate and underlay, the latter is moistened slightly.

It goes without saying that all drawing plates, after the etching and before the printing with any color, have to be rolled in with black printing ink, in order to be able to satisfy one's self regarding the effect, and printability of the design. For this purpose it has to be washed out, that is to say, the India ink or chalk used for marking the design should be removed and its place taken by a sort of fixing agent, which insures the permanency of the design. This washing out of fresh India ink, chalk, or re-impression plates is of great importance, since through the transposition of the chalk, India ink, or reprinting color into a fatty gum layer, greater resistibility and permanency are imparted to the printing surface.

Corrections on aluminium can be performed without difficulty. From the etched and printed plates, small or large surfaces of the designs can be removed and used again for drawing or re-impression. In all cases where changes have been made in a design, the plate should be put in pen-ink and gummed lightly. Next the drawing is washed out with the tincture, the same as in printing over the gum without water. To cause the drawing to remain more visible, a little re-impression ink is added to the tincture. Dry well and carefully rinse off the plate. The whole design must now be visible in a blackish-brown tone and for safety is once more protected by rubbing with talcum.

For direct transfers of photographs in line or half tone, aluminium is far better adapted than stone. In fact, only since the introduction of algraphy (printing from aluminium) has it been possible to execute large direct copies in a faultless manner. The process itself is very simple provided that the equipment of a perfectly dust-free dark room with printing frames, developing dishes, rotary apparatus, etc., is at hand. For copying, a clear reversed negative well covered in the lights is required, the preparation of which can be intrusted to any reproduction photographer.

For reprinting on aluminium any material used in printing may be employed and transfers may also be rubbed on or rolled on, but it is better to use the following method which will yield quicker and surer results and has been adopted wherever printing from aluminium is practised. The process of transferring the prints taken from the original is just the same as in lithography, only in preparing the printed text for designs for printing, a new method is pursued. It is therefore immaterial on what paper, dry or moist, the

prints are made, or whether they are mounted on cardboard or zinc.

The simplest way is, of course, re-impression by means of moist or semi-moist papers, since the plate can then remain dry. For gelatin papers, as well as for the transparent papers, a uniform, very slight moistening of the aluminium plate is necessary. Too much moisture prevents the transferred color from adhering to the metal, so that upon washing out and rolling in the surfaces appear uncovered and the whole reprint disappears gradually when printing from it. A correctly manipulated reprint on aluminium, however, will admit of printing larger editions from it than from stone. Defective re-impressions, however, should never be passed into the hands of the printer, as they quickly become entirely useless.

In transferring autographs, the result depends upon the quality of the original, the same as in lithography. Old autographic ink should never be used for writing or drawing. It is better to use freshly ground lithographic or India ink, or both mixed together. It is essential that the lines made on the paper should still show luster after drying. As regards the paper, only well-sized paper should be used; for traced drawings and plans vegetable paper, not oil paper. The best adapted for re-printing, however, is the autographic paper prepared with a coating of paste.

For pantography or reductions with the gum film, the original plate should be pasted upon a firm support. For this purpose take a smooth sheet of paper of the same size as the plate and paste it firmly on the under-lay of stone or iron, paint the sheet again with gum, lay the plate on top and weight it for a little while. In 10 or 15 minutes it is firmly enough attached to make impressions from it on the gum skin without drawing up the plate when the film runs off. In the coating used for pantographing of aluminium, a few drops of glycerin should be used.

The reduction transferred again upon aluminium is then treated further as described above for re-impression.

Heliotype reprinting especially in connection with aluminium is likely to become an important factor in chromotypography. This process may be applied to colored plates as well as to final or drawing plates. The utilizability of heliotype in the algraphic branch is founded upon the production of a grain suitable for re-impression as well as for subsequent printing and approaching that of a crayon drawing. The formation of the grain is accomplished by admixing a graining reagent to the heliotype preparation. If such an object is to be reproduced, a photographic picture has to be taken of it from which, with the aid of the heliotype process, a picture suitable for algraphic printing can be produced.

Only a few years ago I succeeded in discovering a process to raise the text and designs on aluminium, by sharp etching, thus obtaining a relief, similarly as in lithography, which facilitates the inking and furnishes a rich impression even with moderate cylinder pressure. The relief produced on aluminium, however, does not furnish the same advantages in practical printing, and only by the use of extensive machinery can the relief be removed again, which, besides, renders the plate so thin that a repeated use for the same purpose is impracticable.

Hence, high-relief etching is excluded in practice, but can be readily dispensed with, if the machines are strongly built and the printing cylinder has sufficient tension, since the fragility of the stone has no longer to be taken into account. But since high-relief etching has been unknown heretofore, I will give the process for the sake of completeness; perhaps it may be useful for other purposes. The printing surface to be etched in high relief is blacked with ordinary pen-ink, and then sprinkled with rosin or powdered asphalt; the superfluous powder should be removed by wiping with talcum before it is fused on with the lamp. When the design has thus been thoroughly protected against acid, it can be etched in relief with cuprous chloride. For this purpose dissolve enough concentrated cuprous chloride (crystallized green needles) in water, until it is completely saturated without a sediment. Of this solution, which is of a deep green, take 1 part to 6 parts of water, adding 1-10 part of acetic acid. The etching liquid now finished is pale blue.

For printing from aluminium all strongly built lithographic presses are adapted, but, favored by the excellent qualities of aluminium for printing purposes, an old idea of applying flat printing to rotary machines has finally been carried into effect. As far back as in the sixties, the Parker Arms Company, of Meriden, Conn., erected a machine constructed after the pattern of the rotary book printing press, the cylinder being of lithographic stone. A special machine scraped off the stone when a fresh re-impression was to be mounted, which was again performed by specially constructed machines. The first rotary press for flat printing was very small in size, but is said to have done good work. It soon fell into oblivion, however, since it was too expensive and too difficult to serve.

Meanwhile, zincography has gained many adherents; here and there tolerable printing was done from it in the hand press, which doubtless furnished the incentive to try rotative printing with zinc plates. Germany and France could not find any buyers for their machines, but in the United States the Huber Rotary Press Company was successful in introducing their zinc rotary presses, it is true, only for inferior work, large posters, etc. The Americans took up the perfecting of these machines with renewed energy, when Mullaly and Bullock received a patent on printing from aluminium. Simultaneously the aforementioned process had been invented in Germany, for which patents had also been taken out abroad. The results obtained with the Mullaly process, however, were such that when the German patent had been bought up in America, its introduction was general and the construction of rotary printing presses assumed undreamed-of proportions, which, however, did not take place in Germany.

Four of the largest machine construction companies of America now supply rotary presses for aluminography; the number of machines put in service in a short space of time in the United States amounts to 150 to 160. One establishment alone has fifteen in operation. The United States also supply Japan, Australia, England, France, and South America. The predominating system of the American rotary press shows two constantly rotating cylinders of equal size, a laying-on board with fixed marks, and the well-known layer or lifter, as is used by the book-printers in their machines. The machines latterly constructed in England are built after the American principle without showing a notable improvement. The price of these machines as compared with that of the Americans is remarkably low, but despite this fact two-thirds of the forty rotary presses set up in England are of American origin.

In Germany the first rotary machine for zinc was built in the sixties by the Johannisburger Maschinenfabrik, but without success, nor did their aluminium rotary presses, built in 1896, find any buyers. Only in 1898 a Würzburg factory succeeded in awakening interest with a new system. It is worth while to describe it more fully, as it is at present the only one that has been successfully introduced in Germany, Italy, and Austria. Its print is neat and of good register; it allows of a quick change of plates; can be cleaned conveniently and quicker than other systems, for which reason it is also useful for small editions. The printing cylinder is arrested for the purpose of a new laying-on; the laying-on is done into the grippers of the cylinder on corresponding marks provided there. The printed sheet is passed out through two drums with the printed side up. The plate cylinder carries on one-half the aluminium plate; the other half is used as moistening table on which the damping or wiping rollers respectively rub out their water. For inking, the old system is retained; the distributing cylinders are situated on the inking cylinder, which is moved to and fro laterally and feeds two large rubber cylinders, whose circumference corresponds to the size of the printing surface, whereby even the largest surfaces are covered uniformly. The action is very quiet for a machine with stop cylinder, which is to a great extent due to a cylinder brake.

There is another rotary machine, constituting a combination of the aforementioned and the American systems, in which the Offenbacher Maschinenfabrik is placing great hopes. Simple in the serving and solid in construction, this machine has, despite its eminent advantage over the flat printing press, a low printing velocity; thus, for instance, the impression cylinder has the same revolving speed when making 20 impressions per minute as the printing cylinder of a flat printing press of the same size making 14 impressions per minute. The laying-on and laying-off boards are on the same side of the machine. By this arrangement, the front side at the roller is perfectly free, thus rendering access to the aluminium plate very convenient. A newly patented peculiar taking-off contrivance conveys the sheet without the printed side coming in contact with ribbons, rolls, or laying-off rods. The machine also has two large rubber rollers and a stop cylinder with hard pressure, without springs.

The German machines confine themselves to printing only one color at a time, while the American factories now furnish machines which print two and more colors in succession, without the sheet leaving the printing cylinder, but this class of machines seems only adapted for very special and large editions, since the equipment and serving must needs present some difficulties, both as concerns the machinery and the printing.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT, from the German of Weilandt, in Der Stein der Weisen.

MANUFACTURE OF LANOLIN.

THE text of the patent issued to Braun and Liebreich, January 23, 1883, is as follows:

"Many attempts have already been made to obtain the purest possible fat from raw woolfat, or from the wool-washing water. The methods used heretofore, however, are ineffective, since in the most favorable case the product obtained is sour and has an unpleasant odor, and if benzin, petroleum ether, or other like materials are used for the extraction of the fat the odor of the extracting medium also adheres to the product. The reason of this unsatisfactory result is due partly to the carbonic acid which is always evolved by the decomposition of alkaline liquids, and which attaches itself in small bubbles to the little particles of dirt adhering to the fat and carries up a large portion of the heavy earthy admixtures of the fat, so that upon the sour liquid a dirty muddy mass is formed, from which fat can only be obtained by pressing under heat. Furthermore, during the progress of the operation the lyes pass over into putrid fermentation, causing annoyance to the neighborhood and imparting to the resulting fat an obnoxious odor which cannot be removed. Moreover, this method requires much space and a considerable quantity of acid, because the earthy portions, which always contain decomposable lime salts or silicates, must be saturated with the acids necessary for the separation of the fats. Furthermore, there is a loss of material, due to the portion of the fat which remains in the press-cakes. By our method we are enabled to obtain, first, means for the separation of the dirt and unsaponified fat from each other and from the soapy water before the latter has been decomposed by acid; second, means for the production of lanolin, or of a new compound formed of purified woolfat and water, as above stated.

"In carrying out our invention we proceed as follows: The fresh undecomposed waste liquor or lye is passed through a centrifugal machine, in which the dirt and the fat are separated from each other, while the cleansed soap-liquor is continually drawn off by means of a pipe and led directly into the vat which serves for the acidulation. The raw lanolin thus obtained is thoroughly kneaded by suitable machinery in cold flowing water until the water which flows off is as clear as the water which flows in. The raw lanolin is then heated with water, whereby it is split up into water and fat. The latter is skimmed off from the surface and cooled, and for further purification it can be again treated in the centrifugal machine in a melted condition, or it can be dissolved in ether, ethylated or methylated spirits, or other solvents, and the solution can be separated from the residue by filtration or other means. The solvents can be recovered by treatment in suitable stills. After the fat has been cleaned, as above stated, it is thoroughly kneaded with water for a long time, and a perfect white neutral colorless unguent is obtained which is our new product. From the mud deposited in the lowest part of the centrifugal machine a still further portion of lanolin can be obtained by stirring the same up with clean or salt water and again treating it in the centrifugal machine or extracting it, either in a wet or dry condition, by means of a solvent, after which it is treated as before.

"Instead of producing our lanolin from wool-washing water it may be obtained from commercial woolfat by stirring this wool-fat together with water containing carbonate of soda or caustic soda, or any alkali, or a mixture of these to form a thin milky solution, which is treated in the manner above described.

"We are aware that wool-oil has been obtained by acidulating the alkaline waters used to remove grease from wool, collecting the gelatinous substance obtained, and treating it with a fixed or volatile oil, the latter being afterward driven off by distillation; also, it has been obtained direct from the wool by washing it with volatile oil or sulphuret of carbon and employing gentle heat, as well as by other methods. All these processes are, however, subject to the objections already mentioned, inasmuch as they affect the product either by the odor adhering thereto or by its positive deterioration in quality, or both."

THE SIMPLON TUNNEL AND ITS CONSTRUCTION.

THE London Engineer contains a description of the forms of timbering employed in the Simplon tunnel.

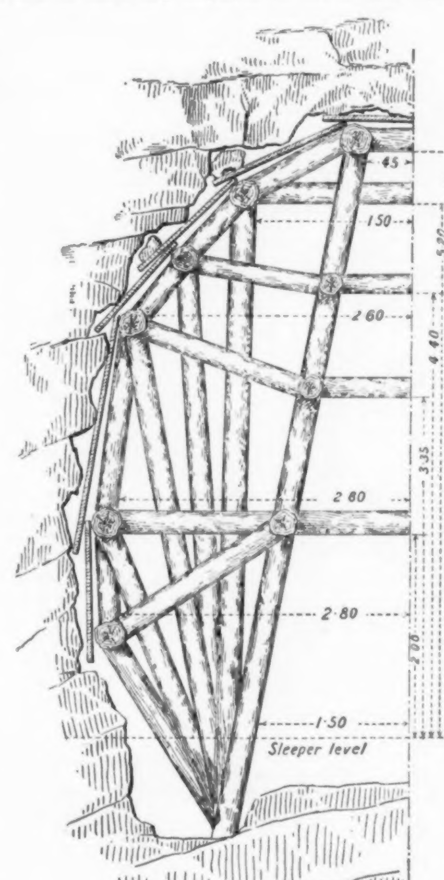
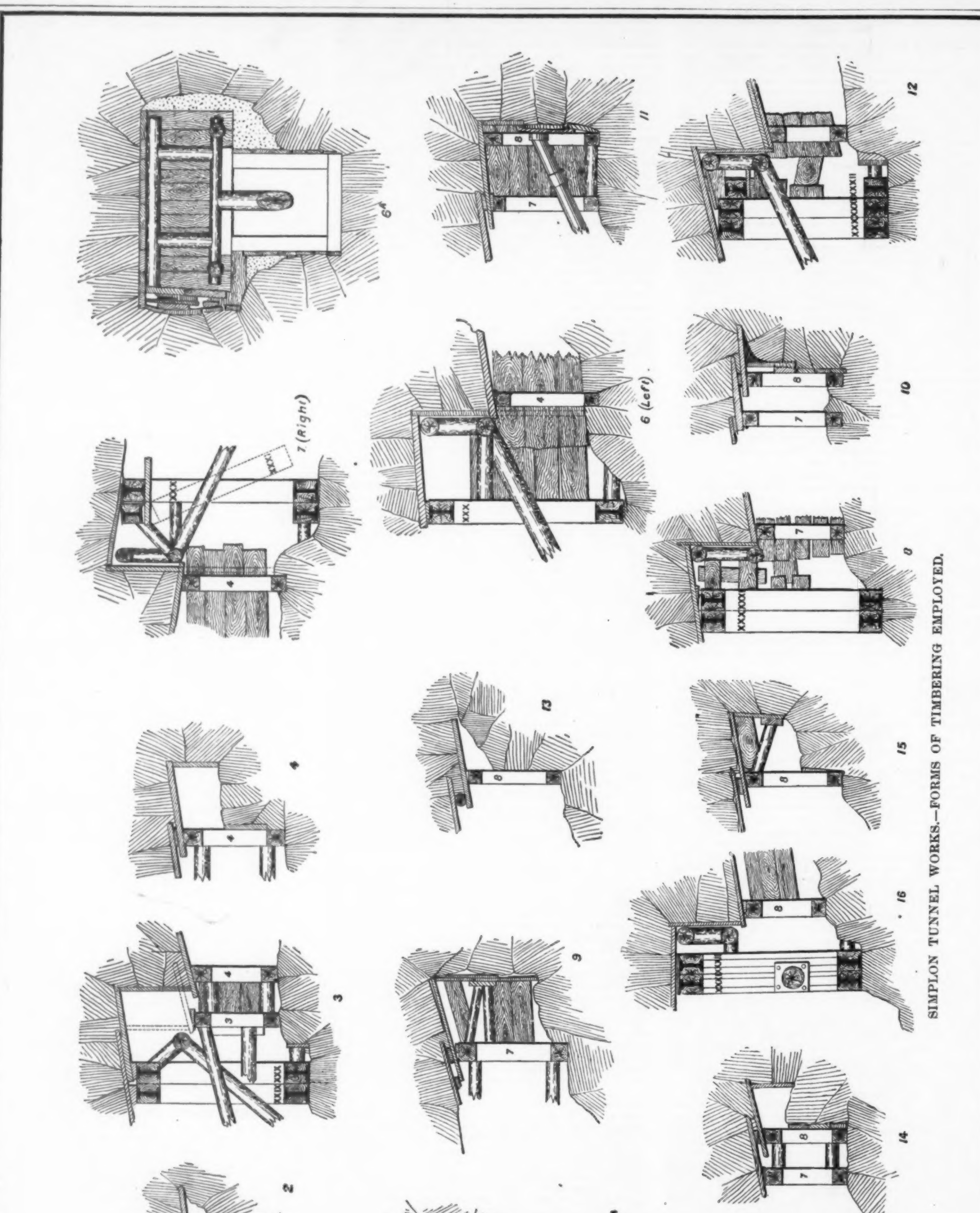


Fig. I Heavy type of timbering for horizontal seams

We have abstracted that portion of the account which should be of most interest to our readers.

It should be noted that for reasons of safety the whole of the tunnel No. 1 throughout was timbered, even where the rock was solid and firm; but the spacing apart of the arch timbers has naturally varied with the character of the stratifications, and thus 10 feet, and even 8 feet only, have sometimes been allowed between centers. The forms of timbering differ somewhat even for a rock of the same nature; for example, where seams, although subject to no real pressure, lie horizontally, the superficial refrigeration of the warm rock in the tunnel has been apt at times to cause a sudden detachment and fall of layers—once with fatal results—and therefore, in such cases a stronger form of timbering has been necessary, together with a closer spacing—sometimes of the type given in Fig. 1. But the long struts used in this construction are not easy to handle in the tunnel, and in another form of framing, wherein the same angle is observed for the central posts, the timbers are shortened by one-half—that is, at the principal transverse beams, extending the full width of the enlarged tunnel, and dividing the wall section from the arch section, the latter being subdivided into seven segments. The primitive stage of this last-mentioned style of timbering is to be seen at the tunnel's mouth.

Masonry.—Wherever possible, it is sought to maintain the masonry following close up to the work of enlargements; but the varying nature of the rock traversed causes frequent disparities in the rates of progress of the two operations. Before reaching the difficult portion of the tunnel, 4,450m.-4,490m., the enlargement was in general 400m. ahead of the walls,



SIMPLON TUNNEL WORKS.—FORMS OF TIMBERING EMPLOYED.

and 500m. ahead of the arch masonry in the tunnel No. 1. At the time of writing the masonry lining is carried right up to the bad portion 4,450m.; and about one-half (20m.) of the footings have been laid in the clay slate, while beyond, in the anhydrite, nearly 350m. of abutment walls have been built, reaching up to near the point 4,800m., and out of this latter portion an aggregate of 40m. of arch work is finished. Omitting the one very difficult part, the most troublesome portion for the ordinary wall work now appears to be past, for there is no indication, up to the present, of any further serious trouble from infiltrations. The most advanced courses or early stages of the wall

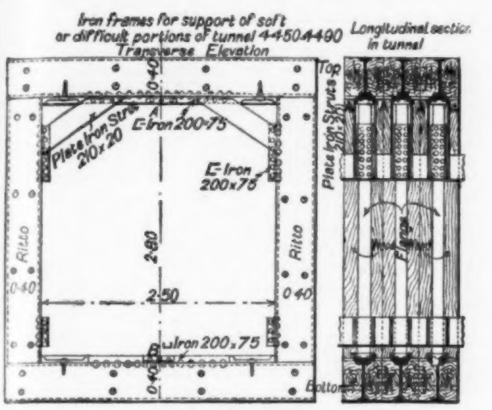


Fig. 3—IRON FRAME

work were at the period previously referred to in this article—and to which we adhere—proceeding through the flooded portions of the tunnel, where the water was of such a depth in places that in wading through it to point out wall details, the engineer serving as guide slipped into a depth where it reached to the hips.

In the construction of the arch, lengths of timber stooling of square section, with posts spaced 6 feet 6 inches apart longitudinally, are erected between the arch timbers of the tunnels, in lengths of about 50m. This framing embraces the full width of the walled tunnel so that a couple of 80 cm. tracks can be laid below it, and traffic to and from the heading, and mineral trains carrying supplies, can pass freely underneath. Upon this framework, and blocked up by the usual wedges for alignment, are mounted the steel arch centers. These, of I section 7 inches deep and bolted together in two pieces, are spaced out at distances between centers depending upon the weight of the voussoirs to be borne. The arch varies in thickness

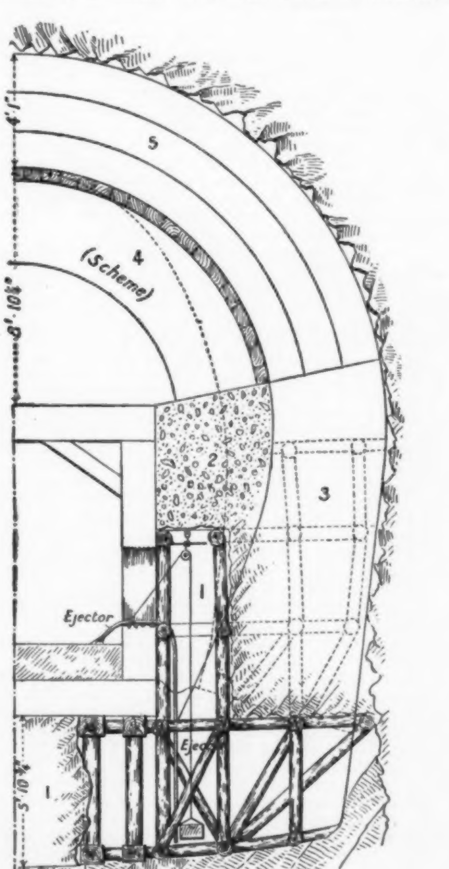


Fig. 4.
Excavation around iron-framed tunnel for building inverted arches (Work now in progress)

from 14 inches in sound rock to between 20 inches and 24 inches for ordinary heavy pressures, and occasionally to 4 feet 1½ inches for the most difficult parts of the tunnel. As it is not possible, even with the most careful hand work, to remove the rock to the exact contour required for the extrados, there is necessarily considerable filling up to be done in addition to the masonry, amounting, on an average, to nearabouts three cubic meters per meter run. This filling-up consists of concrete and rubble, forming a solid mass integral with the arch, differing in this particular form from the St. Gothard tunnel, wherein rammed rubble was employed, and which has of course an advantage on the side of tunnel dryness by its aiding the permeation of water emanating from the natural roof. The lagging boards carried by the centers are put in one by one on either side as the building up of the haunches proceeds, and finally the crown is completed by the insertion of the keystones from the end which remains open—the most difficult part in tunnel arch masonry. Materials are hoisted up to the masons' scaffolding simply by hand and pulley.

The inflows of water from the various springs in the roof and sides of the tunnel were diverted during this work by means of shields of iron suitably bent and stayed up to resist the force of water rushing in from different fissures. A channel of sufficient size to accommodate the volume of water was then formed in hydraulic cement around, the extrados work being carried on the while under cover of the metal shields, which were removed when the work was set; the rubble filling-up then being continued as before. The water from these arch gutters on both sides is brought into the tunnel drain through barbicans pierced in the walls; and this latter drain is of course emptied by the first convenient cross-passage into the tunnel No. 2. In drier parts of the tunnel where the amount of water inflow was insignificant—a mere trickle—the filling-up above the extrados was occasionally tapped with small pipes following the inside contour or the vault down to the side drain; but these outlets have up to the present yielded very little water—indicating at least that no fresh inflows have occurred.

Iron Frames.—We now return to that part of the tunnel armed with iron frames. The frames are of I section 15¾ inches deep, 6⅛ inches wide across the flange, and ⅝ inch thick in the web. The upper ends of the posts and the top beams are braced together by pairs of angle brackets 8¼ inches deep by ¾ inch thick, secured to the flanges of the channel girders by means of shallow channel irons 7⅝ inches wide by 3 inches deep, riveted to the latter, as shown in the drawings, Fig. 3. The posts are stayed against direct lateral stresses by the forged Y stops, which are screwed by their lugs to the top and bottom wooden truss beams, between which it will be noted all the iron frames are sandwiched and securely bolted. Provision is made for angle brackets or gussets, also at the feet of the posts by the same form of channel iron ears affixed to the flanges.

The plan followed for the excavation in the slate clay, or very difficult part of the tunnel between 4,450 and 4,490, will be understood from the sketches that were made during the progress of the excavation for the iron frames Nos. 29 to 32—that is, the last four frames of the first series which were placed in close contact. As will be noticed, the decomposed rock was excavated by an advance drift below, followed by an enlarging drift above. For the timbering of these drifts the advance was made with rectangular frames of square-section timbers, having dimensions over all of 5 feet by 5½ feet; and for the work of enlargement a larger frame composed of two round beams and two stiles was built up, as shown by section 6A, and then shored in place by one, and sometimes by two, heavy struts. Thick lagging and polling boards were driven in all round the excavations as the work proceeded. Occasionally, as in the saturated clay slate of tunnel No. 2, the wooden polling boards were sustained by iron plates with return ends, as have already been represented in the photograph given of the advance heading in tunnel No. 2. Section 1 shows the twenty-ninth iron frame and the wooden frame 3, both in position, and the excavation proceeding forward in the top and bottom drifts, followed by the erection in the lower hole of the wooden frame 4—see Section 2. In the next sections, 3 and 3A, the iron from 30 is now mounted, the top drift advanced and lagged, and the heading is being driven on in advance of the wood frame 4—see Section 4—and in Section 5 longitudinal timbers have been inserted for the support of the retrograde pressure, while the downward excavation is continuing below them. The upper drift shown in Section 3 is now sufficiently enlarged in front of the iron frame 30 for the placing of the trussed framing depicted in Section 6 and 6A, which is supported vertically by an oblique strut wedged against the sleeper of a rearward frame and, longitudinally, also by a beam butting against the previous iron frame. Around these struts the next iron frame—31—is then built, commencing with the sleeper, following with the head or bressumer, and completed by inserting the posts in the manner shown in the right-hand sectional view 7. The advance heading in front of wood frame 7 now proceeds as shown in sections 8 and 9, followed by the erection of the wood frame 8—Section 10—and the shoring up of the advanced drift—Section 11—for the insertion of longitudinal struts between wood frames 7 and 8. The last of the iron frames is now to be erected, as indicated by Section 12, and followed by the commencement of a fresh top drift, as previously shown in Section 1, while excavation is being started in front of the lower wooden frame 7, as in Section 13. The drift now commenced in front of the wood frame 8—Section 14—is shored up as the work progresses, as in Section 15, and boarded up when complete, as in Section 16, in which latter view the last trussed frame in juxtaposition—No. 32—is shown fully completed, and the upper drift being advanced for the erection, after a slight interval, of frame No. 33. The same method of excavation was continued onward for the erection of the remainder of the iron frames, but the more resistant nature of the mica-schist further ahead permitted them to be spaced out at distances apart varying from 13 inches to 4 feet, the last being put in position in the tunnel at the point 4,492.20m., and the spaces between the sandwiched iron frames 32 to 74 are filled up with concrete.

As an illustration of the great pressure exercised upon these strong trussed frames it may be mentioned that near to where the spacing out began, one of the frames between Nos. 35 and 40 has been broken at the roof beam. While waiting for the replacement of this beam it has been strengthened by a strong transverse beam supported at either end by a couple of posts—a repair job which for the moment prevents steam locomotives, with lowered chimneys, from passing, but without any serious inconvenience, as the compressed-air locomotives can clear this spot, and haul the mineral trains forward the short distance to where the masonry walls are now in progress.

Excavation of the material around the outside of

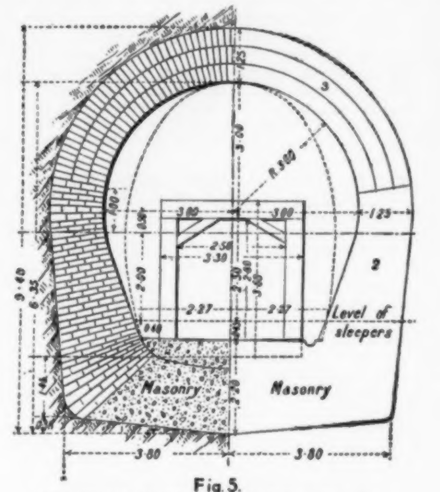


Fig. 5.
Extra special Section for extra heavy pressures between 4450 and 4490 metrical advance showing relative proportions of normal section and iron frame in situ.

the frames commences by first cutting a portion out of one of the posts—just sufficient to allow men and materials to pass through. This work is done simply by hammer and cold chisel, and the excavation then proceeds downward, the shaft as it progresses being strongly timbered and boarded. The sketch—Fig. 4—gives a general idea of this work, but being made from memory, the timbering may not be shown precisely according to the arrangement which is employed. In this particular part the staying and bracing differ frequently to suit local conditions of the clay in the cramped space wherein the work has to be done. Arrived at the bottom of the shaft, sills of square section are laid upon which to erect strong posts, and these latter are driven in under the corners of the iron frames above, immediately room has been scraped to make place for a lintel. This undermining of the iron frames is only effected on a breadth of about 5 feet at a time. Continuing the excavation, a number of posts, always corresponding with the transverse line of the frames above, are at last got in, and as soon as the middle line of the tunnel is reached the inverted arch is built in at once, and as quickly as possible to the fullest breadth available, and up to the undersides of the iron frames, which are then rigidly supported by this foundation. The same process at the same metrical point of advance is simultaneously carried on from the opposite side of the tunnel. Meanwhile the excavation has been carried backward to

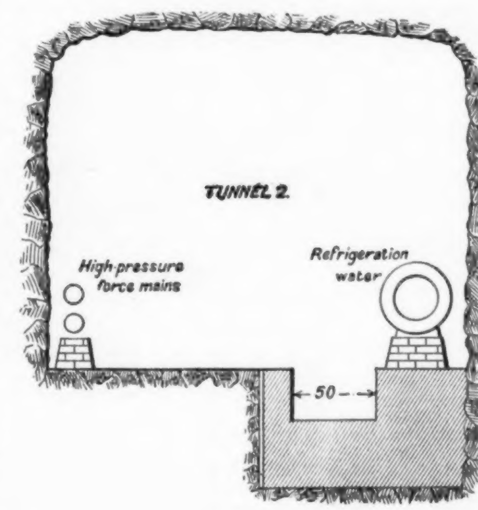


Fig 7.

the outside footing for the arch, and then upward, followed as closely as possible by the foundation masonry. If the wet, decomposed rock contiguous to the portion just built is sufficiently firm, another transverse drift is run under the frames, or, in the case of this being unfavorable, a gallery is driven forward longitudinally to the tunnel's axis until firmer ground for the foundation presents itself. In this way work is proceeding simultaneously at a number of rings of from 3 m. to 5 m. apart, which serve later on as a basis for working in the unstable material which had until then been avoided.

The work here is unquestionably the most interesting in the tunnel, with the element of uncertainty at all times present; yet it is not the most comfortable of places for an engineer in charge, for the air is not the best of tunnel air, and the black mud soon envelops everything, while a number of hydraulic injectors of various sizes have to be kept running to lower the water, which enters here as in a well.

After laying the foundation arch, it is the part which lies between the outer sides of the iron frames

and the inside of the wall to be built that is now excavated (2) and filled up at once with temporary masonry, which then becomes a lateral support for the timbering in the outer space next to be excavated (3). The section of this part of the tunnel, as compared with the normal section, and the form of the masonry courses are shown in Fig. 5.

The abutments for this arch have at the present time been completed for a length of about 20 meters, but the enlargement for the vault has yet to be accomplished. The method of carrying out this work does not so far appear to be definitely fixed. One plan out of many is to turn a temporary arch of dry masonry (4) above the iron frames and abutting upon the temporary masonry (2) at the sides. This would form a solid basis for the support of the heavy timbering that will be necessary for the shoring up of the large surface described by the extrados of an arch of this section, and it may ultimately serve as centering for the voussoirs. Something rather similar was, it may be remembered, adopted for the extra-difficult parts in the excavation of the Christiana tunnel traversing the Apennines.

The water inflows have, as is readily conceivable, been troublesome; but this 40 m. stratum of rotted mica-schist has been, and still is, the most serious of all the obstacles yet encountered in the whole course of the work of the Simplon. More than a year has already been spent in it, and it will probably require another year before it is completed, including, of course, the enlargement and lining of the same bad portion of the twin-tunnel No. 2, where work is now progressing according to the experience already gained in the main tunnel. The work of dressing up the course of the tunnel No. 2, in the short length lying between the inundated part and the commencement of the black clay is shown in Fig. 6. This auxiliary tunnel being now pierced from its mouth to the heading, advantage is taken of its cooler atmosphere for the conveyance of both the high-pressure water mains—one only of which had been carried along tunnel No. 1, as has been noted previously. This disposition, therefore, resembles the arrangement already adopted at the Swiss side and shown by the sketch, Fig. 7.

DELAY IN THE CONSTRUCTION OF GOVERNMENT VESSELS.

THE matter of the delay in the completion of vessels of the navy now under construction has been the subject of an interesting correspondence between the President and the Secretary of the Navy. Much comment has been caused by the fact that so many vessels have run over contract time, and by many months. Under date of February 14 the President called the matter to the attention of the Secretary of the Navy. The Secretary's reply, with the accompanying statement by Admiral Bowles, chief constructor, covers the subject exhaustively, and shows that while through a number of causes the building of war vessels has been delayed and the dates of their completion have been and will be considerably beyond the dates originally set, naval construction in the United States is not materially behind the naval construction of England and Germany in the matter of time. In his reply to the President Secretary Moody says:

NAVY DEPARTMENT,
WASHINGTON, February 18, 1903.

Sir: I have the honor to acknowledge the receipt of the letter from Secretary Cortelyou under date of February 14, 1903, directing me to furnish you information upon the subject of the delays in building vessels of the navy.

On the 6th of February I directed the Bureau of Construction and Repair to report to me upon the same subject, and believe that the report made in accordance with that direction on February 13 covers to a very considerable extent the information which you desire. Accordingly I have the honor to submit a copy of the report with this communication. I respectfully invite your attention especially to paragraph 12 of the report, in which it is shown that the comparisons ordinarily made as to the speed of the completion of our own ships and those of foreign nations have been in some cases misleading, on account of the fact that in England the ships are reckoned as completed at the time of their delivery under the contract, while in point of fact much remains to be done after that time to prepare the vessels for sea.

In further compliance with your direction, I inclose copy of a table showing the delays in each case beyond the contract time of the ships under construction.

With reference to your inquiry as to whether or not there is any way in which contractors can be penalized for the delay occurring on government vessels, I beg to say that the contracts for all naval vessels contain clauses specifying the time in which the vessel shall be completed, and stipulating that in case this time is exceeded certain deductions shall be made from the contract price. For instance, in the case of the battleship "Missouri," for which the contract period is thirty-two months, the deduction or penalty specified is $300 a day during the six months next succeeding the expiration of the contract period, and for each and every day exceeding six months $600 a day. In the case of the battleship "Louisiana" the contract period is forty-two months, and the penalty is the same as noted above. The penalties for smaller vessels are generally proportional to the contract price.

The contracts contain in all cases provisos that such penalties shall not be enforced when they are caused by the act of the government, or by fire, or water, or any strike, or by circumstances beyond the control of the contractor. For several years past every application of contractors for extension of time on contracts has been accompanied by statements, substantiated by government officers, showing that the delays incurred have been due to these excepted causes; and, in consequence, the department has, by granting the extensions, remitted the penalties or deductions.

I beg leave to say further that some two months ago I directed that no further extensions of time should be permitted except upon my own personal responsibility, to be exercised after a careful examination of the application for extension of time, with all the reasons alleged for such extension.

It seems to me that it would be wise to allow the publication of the report of Admiral Bowles. There is a great deal of public interest in this subject now, and the report is instructive. Unless you should think it would be unwise to allow the report to be made public I will seasonably have it done.

I have the honor to be, very respectfully,
WILLIAM H. MOODY,
The President. Secretary.

The report of the Bureau of Construction, signed by Rear-Admiral Bowles, Chief Constructor, is as follows:

NAVY DEPARTMENT,
BUREAU OF CONSTRUCTION AND REPAIR,
WASHINGTON, D. C., February 13, 1903.

Sir: 1. Referring to the Department's first indorsement No. 15572 of the 6th instant, on a letter from the Bureau of Navigation No. 2036-1 of the 5th instant, recommending the adoption of some means to reduce the period of construction of our naval vessels, the Bureau submits the following statement:

2. The delays in the construction of United States vessels may, in general, be attributed to one or more of the following causes:

(a) Inadequate plans.

(b) Changes in the disposition of armor or armament, or in the details of the designs after the award of the contract.

(c) Delays in delivery of armor and ordnance.

(d) Delays due to government inspection.

(e) Delays due to slowness of delivery of steel and other structural materials by subcontractors.

(f) Delays due to inadequate facilities or insufficient ability in the contractors' technical staff.

(g) Delays due to an inadequate supply of skilled workmen.

Taking up these subjects in the order mentioned, the Bureau desires to state as follows:

3. Inadequate Plans.—In the past the desire of the Department to have the contracts for vessels awarded as soon as possible after their authorization by Congress has led to great haste in the preparation of the contract plans, in which many matters of importance in working up the details were left for consideration after the award of the contract. While this may have appeared at the time to hasten the completion of the vessel, experience has shown that the contrary is the case. The Bureau has taken up this question with great care, and it is believed that in the designs of the "Connecticut" and "Louisiana," the "Tennessee" and "Washington," and the "Dubuque" and "Paducah" the plans have been elaborated in such manner and have been considered in such detail that the work can be prosecuted in the earlier stages with much greater rapidity than has heretofore been the case.

4. Changes in the Disposition of Armor or Armament, or in the Details of the Designs after the Award of the Contract.—The preparation of inadequate plans leads more or less directly to the second cause of delay. It has not infrequently happened that elaborate changes in the arrangements of the armor and of the battery have been made after the contracts have been signed. Indeed, the contracts have contained a clause by which such changes could be made within six months of the date of the contract without any increased compensation to the contractors. Vessels have been lengthened and batteries increased, the arrangements of the turrets and supports have been greatly changed, and other changes have been made too numerous to mention. Changes have not infrequently been due to the development of the art of naval construction during the progress of the vessel, such as the use of fireproof wood and the omission of woodwork as far as possible; the installation of elaborate systems of ammunition hoists not originally contemplated, made necessary by the increased rates of fire found feasible in the development of ordnance, which were not contemplated at the time of the design, etc. The Bureau has taken into account these matters in the recent designs above mentioned, and has anticipated as far as possible all advancements in the art up to date, and it is confidently believed that no serious changes or alterations will be necessary in the progress of construction. Delays from this cause may be greatly diminished by a refusal to adopt experimental propositions for incorporation into designs which have been properly elaborated, and changes of importance made only when it is clear that if such changes were not made the vessel would be distinctly inferior in its fighting qualities.

5. Delays in Delivery of Armor and Ordnance.—These delays have constantly occurred. They have been due in the past, first, to the discovery of improved methods of manufacture of armor, such as the Harvey process, which greatly delayed our first battleships of the "Indiana" class; second, by the Krupp improvement on the Harvey process; third, by the controversies which existed as to the price of armor, and the refusal of Congress to authorize the building of vessels until the contractors for armor had acceded to certain demands as to the maximum price. The latter has been one of the principal causes of delay in the "Maine," "Missouri," and "Ohio," of which the first only has been commissioned, nineteen months after the expiration of the contract date of completion. It is to be hoped that the productive capacity of the armor makers will in future be sufficient to supply the requirements for ships now under contract. The delivery of the ordnance has been a constant source of delay, and few, if any, of the vessels which have been building by the navy have had their batteries completed in good time, even allowing for the delays which have occurred from other causes. The delivery of ordnance is likely to become a very serious matter on the vessels now building. With seven battleships, eight armored cruisers, and three protected cruisers of large size building, a very large quantity of ordnance supplies will be necessary within a short interval of time.

6. Delays Due to Government Inspection.—It is believed that the inspection given to United States vessels of war is more complete than that given by any other nation, and this extends not only to the vessels themselves, but to the materials used. Such inspection, including criticism of plans, etc., necessarily tends to a slower construction than when the contractor is given a free hand, but in the opinion of the Bureau, it is not desirable to relax the rigidity of such inspection. Arrangements have been made, however, by which superintending constructors are required to make monthly reports of the causes of delay when such exist, and the Bureau calls the attention of the Department from time to time to such matters, so that both the inspecting officers and the contractors are kept alive to the necessity for avoiding delay.

7. Delays Due to Slowness of Delivery of Steel and Other Structural Materials by Subcontractors.—These delays have assumed great importance on the vessels now under contract, and on all those for which the contracts date from the beginning of 1898. In that year the phenomenal rise in the demand for steel occurred, and has continued without interruption since. The demands for shipbuilding purposes are comparatively subsidiary to the great demand for structural material throughout the country, and, as a natural result of their comparative insignificance, do not receive as much attention from steel manufacturers as deliveries for other work, which it is thought is profitable by reason of greater tonnage and cheaper quality.

8. For vessels recently begun or to be begun in the near future this source of delay is believed to be the one serious obstacle affecting the hull construction of vessels by the shipbuilders or by the government. For reasons not known to this Bureau, and not entirely clear, although the steel manufacturers of prominence have taken and are taking contracts for ship's steel on the government specifications in large quantities, they do not devote, even if they have available, a sufficient plant to manufacture this material with sufficient rapidity to furnish the shipbuilders a continuous supply equal to the amount which they should consume in the regular process of building ships to comply with the contract periods now being assigned. In other words, the capacity of the steel manufacturers is inadequate to furnish a sufficient supply to the shipbuilders, even if the steel mills were willing in the production of the material to follow closely the order in which it is required by the shipbuilders to suit the construction of ships. As a matter of fact, the steel makers pay but little or no attention to the requests of shipbuilders for the delivery of the keel plates, the framing, the bottom plating, plating of decks and bulkheads, in the order in which they are required in the construction of the vessel, but usually attempt to manufacture the material in a method most economic to themselves, resulting in the grouping of materials of similar dimensions without regard to the shipbuilders' interests.

This neglect on the part of the steel manufacturers is now a source of constant complaint on the part of the shipbuilders and of the government in its own contracts, and has repeatedly been brought to the attention of the steel manufacturers without securing permanent relief. It is necessary for all large shipbuilding firms to keep at the steel works men whose sole employment is to try to secure the material in the proper order. The delays and disorganization caused to the shipyards, and the very considerable financial losses caused to them by these delays are adversely affecting the efficiency of naval vessels. In the case of merchant vessels, many shipbuilders have recently resorted to placing orders for structural steel in Scotland and Belgium, by which means they secure the material in the order required within a definite time—for less than it can be obtained in this country. This resource is not open to builders of government vessels, as they are required by law to be built wholly of materials of domestic manufacture.

9. It may be well to discuss here, incidentally, the effect of allowing a bonus to ship contractors, as suggested by the Bureau of Navigation. It is clear from the above statement of one of the principal organic causes of delay in shipbuilding, that no bonus would be effective in reducing the time unless it were sufficient in amount and paid to the shipbuilder in such a manner as would enable him to pay the steel maker a much greater price for the steel so that it would be given priority over all other orders, and would be produced and delivered in the order of the building of the ship. It can readily be seen that the period of construction of any particular vessel might be hastened, but it would be impossible to hasten the construction of all vessels building by such means, because the capacity of the steel manufacturers being limited, and working to their limit at the present time, the paying of a higher price on the part of everyone concerned would simply be a waste of money and produce no better results than at present. This would be more clearly and particularly the case for nickel steel, in which the capacity for production is now below the needs of the navy, and of which the government is practically the only large consumer.

10. Delays Due to Inadequate Facilities or Insufficient Ability in the Contractors' Technical Staff.—In the past the government has awarded contracts to shipbuilding yards that were possessed of totally inadequate facilities for the building of the vessels contracted for. This has been, in a measure, due to the necessity under the law of awarding the contract to the lowest responsible bidder and in part to the policy of awarding contracts to the various shipyards throughout the country under which they could develop their plants and facilities for doing government work in the future. This was notably the case in the awards of the small cruisers, destroyers, and torpedo boats made in 1898. It unfortunately happened that the contractors did not always provide the facilities which they lacked, and it further happened that owing to the amount of work ordered, not only by the government but by private parties, in 1898 and 1899, the demand for persons equipped with competent technical knowledge greatly exceeded the supply, a condition which is still felt, not only by private establishments, but in the government's own service. As a result, the stronger concerns have been able to outbid the weaker and smaller concerns, as they were unable to pay the salaries demanded. This was particularly unfortunate in the case of the destroyers and torpedo boats above mentioned, which, in their construction, in-

volved the highest quality of designing talent. Such delays as have occurred will diminish with the development of competent technical staffs in the various shipyards and with the award of contracts only to people who can demonstrate that they have, at the time of the contract, adequate facilities, adequate capital, and a competent technical staff. The question thus becomes largely one of policy of the government in awarding contracts and in restricting awards to the concerns having the best facilities.

11. Delays Due to an Inadequate Supply of Skilled Workmen.—The withdrawal from the merchant service of a large part of the United States registered tonnage for war service and for transports in 1898, coupled with the authorization by Congress in 1898 and 1899 of war vessels whose displacement was about 65 per cent of all vessels of the new navy theretofore authorized, created a boom in shipbuilding such as had not been known since the civil war. The supply of trained workmen was totally inadequate to the greatly increased demand. With the competition of shipbuilders for workmen, wages rose steadily without producing additional supplies of men. The demand for merchant vessels has recently fallen off greatly, owing to the probable failure of the subsidy bill, so that this cause of delay is likely to diminish somewhat in the future.

12. In the above the Bureau has considered the causes of delay, and has also mentioned in part the steps which it has taken, in so far as work under its cognizance is concerned, to diminish such delays. Notwithstanding all the difficulties which have been mentioned and the state of the art in this country, the Bureau is of the opinion that the period actually occupied from the time orders are given to build a vessel until the time that ship is ready for commission in actual service compares not unfavorably with the best results obtained in foreign countries, namely, England and Germany. The greater apparent speed of ship construction in England is due to the fact that time is usually reckoned from the time the keel is laid until delivery of a contract-built ship. Such vessels are delivered in a very incomplete condition, and are afterward subjected to their trials and supplied with their guns and mountings and a large amount of their equipage at the government dock yards. The actual time from the date of contract to the date of first commissioning of the English battleship "Russell" (to be commissioned this month) is four years and one month, and that is the time which should be compared with the period of construction usually given for our vessels, which averages for the ten battleships already completed four years and eight months. In the German navy the battleship "Wittelsbach," the keel of which was laid September 30, 1899, and which was probably ordered several months previous to that date, has not yet been placed in service. She recently ran aground while on her trial and is understood not to be ready for regular service yet.

13. In this connection the Bureau desires to point out that the desire of the government in the past for the early delivery of vessels, and inexperience in the time required for the completion of the largest types, has led to the fixing of an inadequate contract time for their completion. Thus, the earliest battleships of the "Indiana" class had the contract time for completion fixed at thirty-six months, which was followed for all the battleships and larger cruisers up to 1898, when the desire for rapid construction, following the Spanish-American war, led to the cutting down of the contract time for the "Maine" class to thirty-two months, notwithstanding the fact that no battleship for the government has been completed within a period of less than four years from the date of the contract. In the case of the "Maine," the only vessel of the class yet completed, the elapsed time from date of contract to date of commissioning is four years and three months. The proposition, therefore, of the Bureau of Navigation that a bonus should be offered to the contractors has virtually already been tried, in that a contract time of completion which was very short has been fixed upon, together with penalties for failure to complete in the contract time. The result of this has been that the contractors have practically always been relieved of penalties owing to failures of the government to deliver armor or ordnance, or to the inability of the contractors to get structural materials, or to changes made which delayed the work, and, indeed, has resulted in suits against the government for large sums, based upon the claim that the contractors would have been able to complete the ship in the contract time specified had not the government caused delay by the nondelivery of armor, etc.

14. It therefore becomes a matter of careful consideration what should be the contract period for completion fixed in the contract. In the opinion of this Bureau such time should be adequate for construction, and therefore should be such as to enable the government to impose the penalties called for by the contract in case of delay by the contractors, provided it had itself fulfilled the requirements as to delivery of armor and ordnance necessary to complete the work. The policy of offering a bonus for completion at an earlier date than the time called for by the contract would be not unlikely to involve the government in suits for the payment of such bonuses without the vessel being hastened in delivery in case there should be any delay on the part of the government or failure to deliver at an early date the armor, ordnance, and other things which the government has to furnish in order to complete the contract.

15. In conclusion, the Bureau believes that as far as the delays on the part of the government are concerned this Bureau has taken all such steps as are possible for work under its cognizance to avoid such delays in the future, and also believes that in general contractors for government vessels have used and are using the very best efforts within their several means and abilities to complete their contracts in the shortest practicable time, an object which is most obviously to their own advantage in reducing the final cost.

Very respectfully, F. T. BOWLES,
Chief Constructor U. S. Navy, Chief of Bureau.
The Secretary of the Navy.

NAVY DEPARTMENT, BUREAU OF CONSTRUCTION AND REPAIR.

VESSELS UNDER CONSTRUCTION, UNITED STATES NAVY. *February 1, 1903.*

No.	Name.	Speed.	Contractors.	Degree of completion. Jan. 1.	Degree of completion. Feb. 1.	Months behind contract time on Feb. 1, 1903.
	Battle Ships.					
		Knots.		Per cent	Per cent.	
11	Missouri	18	Newport News Co.	81	84	21.5
12	Ohio	18	Union Iron Works	58	60	30.6
13	Virginia	19	Newport News Co.	14	18	15.6
14	Nebraska	19	Moran Bros. Co	13	15	15.5
15	Georgia	19	Bath Iron Works	19	20	16.8
16	New Jersey	19	Fore River Ship and Engine Co.	23	26	13
17	Rhode Island	19	......do	23	26	13.2
18	Connecticut	18	Navy-yard, New York	1	1	....
19	Louisiana	18	Newport News Co.	1	1	....
	Armored Cruisers.					
		Knots.		Per cent.	Per cent.	
4	Pennsylvania	22	Cramp & Sons.	40	42	7.5
5	West Virginia	22	Newport News Co.	42	44	8.1
6	California	22	Union Iron Works	18	20	16
7	Colorado	22	Cramp & Sons	44	46	7
8	Maryland	22	Newport News Co.	41	43	8 8
9	South Dakota	22	Union Iron Works	18	22	16
	Protected Cruisers.					
		Knots.		Per cent	Per cent.	
14	Denver	17	Neafie & Levy	86	86	11
15	Des Moines	17	Fore River Ship & Engine Co.	78	79	12.5
16	Chattanooga	17	Lewis Nixon	68	68	13
17	Galveston	17	Wm. R. Trigg Co.	66	66	15.75
18	Tacoma	17	Union Iron Works	61	64	19.5
19	Cleveland	17	Bath Iron Works	91	91	8.9
20	St. Louis	22	Neafie & Levy	13	14	16
21	Milwaukee	22	Union Iron Works	9	10	16
22	Charleston	22	Newport News Co.	23	27	11.4
	Monitors.					
		Knots.		Per cent.	Per cent.	
8	Nevada	12	Bath Iron Works	99	99	22.4
9	Florida	12	Lewis Nixon	96	97	23.67
	Torpedo Boat Destroyers.					
		Knots.		Per cent.	Per cent.	
6	Hopkins	29	Harlan & Hollingsworth	95	95	34
7	Hull	29	......do	97	99	33.25
8	Lawrence	30	Fore River Ship and Engine Co.	99	99	36
9	Macdonough	30	......do	98	98	35
	Torpedo Boats.					
		Knots.		Per cent.	Per cent.	
19	Stringham	30	Harlan & Hollingsworth	98	98	48.25
20	Goldsborough	30	Wolff & Zwicker	99	99	(a)
27	Blakely	26	Geo. Lawley & Son	99	99	40
29	Nicholson	26	Lewis Nixon.	98	98	41
30	O'Brien	26	......do	98	98	41
34	Tingey	26	Columbian Iron Works	85	90	42.5
	Submarine Torpedo Boats.					
		Knots.		Per cent.	Per cent.	
1	Plunger	8	Lewis Nixon	99	99	16
4	Grampus	8	Union Iron Works	91	92	21.75
6	Pike	8	.. do	85	88	21
7	Porpoise	8	Lewis Nixon	90	99	19.5
8	Shark	8	....do	98	98	18.5
	Steel Tugs.					
		Knots.		Per cent.	Per cent.	
8	....	12	Navy-yard, Boston	2	10	....
9	....	12	Navy-yard, Mare Island	0	0	....

a In hands of government for completion.

THE ALLEGED MEDICINAL PROPERTIES OF THE HUSK OF THE COFFEE BEAN.

ABOUT a year ago Dr. L. Restrepo, of Medellin, the capital of the department of Antioquia, in the republic of Colombia, South America, convinced himself that the husk of the coffee bean was of great utility in the treatment of several diseases, and that in malaria it sometimes succeeded where quinine had failed. Having regard, on the one hand, to the immense importance of such a discovery, if it were verified, and, on the other hand, to the remoteness of the republic of Colombia from the acknowledged centers of medical activity, some credit is, we think, due to the British Legation in Bogotá, the capital of the country, for having forwarded copious details of Dr. Restrepo's observations to the proper authorities in London—of course, without anything of the nature of official indorsement. Dr. Restrepo at first used an infusion made with 45 grammes of crushed coffee (in the husk) and 400 grammes (about 14 fluid ounces) of water. This was boiled for five minutes, strained, and taken in one day in six doses. With this medicine he successfully treated five patients of whom three suffered respectively from intermittent malarial fever, chronic malarial fever, and pernicious fever, and two suffered from enteric colic or chronic dysentery of malarial origin. Before taking this infusion these patients "had all been declared fatal cases, given up by well-known doctors of good reputation." He afterward made the infusion with 30 grammes of coffee husk alone in place of 45 grammes of crushed coffee in the husk, the other details of preparation and the dose being as before. With this he says that he "treated hundreds of cases, not one patient has died, and a cure has resulted in every instance." For administration in influenza he dissolved in the decoction of coffee husk an amount of tartar emetic which, according to the account sent us, is so heroic that there is probably some mistake in the description.—Lancet.

THE ART OF REJUVENATING PLANTS.

BEFORE a recent sitting of the Académie Française Prof. Lucien Daniel read a paper disclosing some of his investigations into the art of rejuvenating decaying or decayed tissues. It is a great pity that this art so eminently controlled by Prof. Daniel is as yet not practicable for the human race, else he might easily possess himself of some of Mr. Carnegie's millions, not to mention the millions of other wealthy men who doubtless crave the same boon, though they have refrained from making public protestation of it.

The process followed with such great success is only thus far practicable upon plant life. However, being so successful here, he may be tempted to essay further experiments, which will realize the dream of the early alchemists, and eventually confer upon the human family eternal youth without the aid of the fabled fountain.

Much then as we poor mortals may regret the impossibility of his transfusing new life into our dying frames we may yet find it interesting, if not hopeful, to follow the various steps pursued by Prof. Daniel in counteracting the appearances of age which present such a marked characteristic in the whole organic world. He points out conclusively that with the help of various expedients the peculiar properties of plants may be considerably altered.

Thus the ordinary florist with his sheltered conservatory may and does, by the application of heat and moisture, advance or retard the blooming time of plants. In certain plants it is also possible to promote a second blossoming and a second fruition in the same year, as with roses and strawberries. Furthermore, Daniel investigated the effects of grafting upon plants, and to what extent the nature of the scion wood was changed. He grafted tobacco upon the tomato; whereby the tobacco plant became, instead of an annual, a biennial plant; but the tobacco plant did not bloom until the second year. Having experimented with various sorts of beans, grafting one upon another, he finally obtained the seed of a new variety of bean which bloomed and bore fruit twice in the same year.

The question of rejuvenation now occupied his attention, and he entered upon it with all the more zest, since till now no one had attempted to build up failing strength or vigor in plants or to make young and fresh such parts as threatened to decay and die, by grafting them upon youthful and thriving plants. In this case he worked with a plant which is found in the botanical gardens of Europe and America and is one of the first to bloom in the spring, the *Scopolia carniolica*. It belongs to the same family as the night shade, the potato, the belladonna, the hyoscyamus (henbane), and the tomato.

This plant, the *Scopolia carniolica*, having borne its fruit, begins to die as early as the month of May. But at this time the tomato is just beginning to develop and grows extraordinarily strong. At this period Daniel grafted the dying shoots of the *Scopolia* upon the young tomato; and in spite of the appearances of old age shown in the scion before the grafting, after they had set new life began to spring up, new sprouts to shoot forth, new branches put out leaves, and all became green and vigorous. Indeed, some of them blossomed again and bore fruit as in the early spring.

ROAD BUILDING WITH CONVICT LABOR IN THE SOUTHERN STATES.*

By J. A. HOLMES.

THE principle which obtains in the punishment of the criminal is the prevention of crime, both by reforming or permanently confining him and by deterring others from following his bad example. In the accomplishment of this purpose it has come to be generally admitted that during the infliction of punishment the physical health of the prisoner should not be impaired, and that everything possible should be done looking to such improvement of his character as may fit him for better citizenship.

Another principle, in no sense out of harmony with the first, and which, in this connection, is worthy of more general acceptance, is that the prisoner who has injured a community through the commission of crime, and whose capture, conviction, and punishment have added to its financial burden, should, if possible, in connection with his punishment, do something to benefit the community which he has injured. The correctness of this principle is coming to be widely accepted in the Southern States, where the belief prevails that perhaps the best way in which a criminal can benefit the community he has injured is in helping to improve its public highways. And in doing this work without compensation and at a cost actually less, in many cases, than that of his keep in the county jail, he is benefiting his community without imposing on it an additional tax burden; he is not in the ordinary sense competing with hired labor, and he is doing work which hired labor does not care to do unless paid such wages as will prove a too serious drain on the public treasury.

This method of employing convict labor in a majority of the Southern States may be fairly said to have passed the experimental stage, and to have become a part of the accepted practice.

The following table illustrates the extent to which this method of employing convict labor has already been adopted in a number of the Southern States:

DETAILS OF EMPLOYMENT OF CONVICT LABOR ON ROADS IN THE SOUTHERN STATES.

State.	Number of counties in the State.	Counties reporting.	Counties using convicts on public roads.	Average number of convicts employed on public roads during 1900.	Average cost of guarding and maintenance per convict per day on the roads.	Average cost per prisoner per day for keeping in county jails.	Number of prisoners usually kept in county jails, and not employed on roads.	Average cost of hired road labor per day.	Yearly value of labor of convicts employed on public roads during 1900.*	Yearly value of labor of prisoners usually kept in county jails, and not employed on roads.
Alabama	66	66	2	25	†$0.81	$0.30	789	$0.90	$6,187	$195,387
Arkansas	75	70	21	62	†.85	.75	320	.95	16,197	83,600
Florida	45	44	11	106	.46	.40	437	.92	26,818	110,561
Georgia	137	129	27	946	.26	.35	1,073	.60	156,090	177,045
Kentucky	119	109	42	419	.52	.50	583	1.00	115,225	160,325
Louisiana	59	57	9	67	.50	.40	337	1.00	18,425	92,675
Mississippi	75	74	12	113	.25	.30	397	.60	18,645	65,405
North Carolina	97	97	24	643	.24	.30	607	.75	133,508	125,193
South Carolina	40	36	32	579	.18	.30	404	.75	119,418	83,325
Tennessee	96	88	37	722	.26	.40	888	.80	158,740	195,360
Texas	229	214	65	672	.30	.45	1,197	1.15	211,520	378,551
Virginia	100	95	5	23	.38	.30	329	.80	5,060	72,380
Total or average	1,138	1,079	287	4,377	†$0.33	‡$0.35	§7,361	.85	985,823	1,739,807

* In estimating the value of this convict labor the per diem paid ordinary laborers in the respective States as shown in the column giving the average cost of hired road labor per day is taken as a basis; and it is assumed that 275 work days may be reasonably counted upon for these States.

† In determining this average the figures for Alabama and Arkansas were omitted, owing to the probability that certain expenses connected with the maintenance of the teams have been, by mistake, included in the figures reported from these States.

‡ In determining this average the figures for Arkansas have been omitted as being abnormally high.

§ Concerning this total number of prisoners in the county jails of these 12 Southern States, it should be stated that an unknown proportion, probably in some States at least 50 per cent. of these are persons awaiting trial and unable to give bond. This situation may continue for from a few days to several months. The remainder of these prisoners have already been tried and convicted, but remain in jail idle, at the expense of the county, for the reason that no employment is provided for them.

As will be seen from the table, the use of convict labor in public-road building is most largely practised in the States of Georgia, Tennessee, Texas, North Carolina, South Carolina, and Kentucky, in the order named. In Virginia, where only twenty-three convicts are reported as having been used on the public roads of the State, and these confined to four counties, and in Alabama, where only twenty-five convicts are reported as being used on the public roads in two counties, the system is still in its infancy. In Arkansas, Florida, Louisiana, and Mississippi the system has been more largely adopted, but in these States only short-term convicts are used, and in most of the counties the number so employed is small; consequently the per capita expense is large, which is also the case in Alabama. Hence, even in these States, the custom has not yet been established on a satisfactory basis.

Laws of the different States on this subject usually specify that only able-bodied male convicts sentenced for short terms are to be assigned to work on the public roads. In the States of Virginia, West Virginia, Kentucky, Tennessee, Louisiana, Mississippi, Texas, Florida, and Georgia prisoners convicted of misdemeanors only may be assigned to work on the public roads, and for these the sentence does not usually exceed one year, which, when the costs are added, may be thereby extended to nearly two years in extreme cases. In Alabama, in a few cases, all able-bodied male prisoners whose terms of sentence do not exceed two years may be assigned to work on the public roads. In South Carolina this limit is extended to five years, and in North Carolina to ten years.

FIG. 3.—CONVICTS GRADING A PUBLIC ROAD IN SHELBY COUNTY, TENN., ABOUT 15 MILES NORTHEAST OF MEMPHIS.

The soil from the top of the hill is brought by the dump carts to the flat below, where it is being used in making a fill 4 feet high.

The experience in North Carolina during the past ten years has shown that all the able-bodied male prisoners whose terms of sentence do not exceed ten years may be successfully employed at the ordinary work of highway improvement. Many such prisoners in different Southern States whose terms of sentence range between one and ten years are now employed under either the lease or contract system, or under State control, and are working on farms or in mines and factories. All of these might be employed in improving the public highways. The expense entailed would not be great; the difficulties which seem to stand in the way would disappear in practice, and the result would be of incalculable benefit in helping along industrial and educational development in each of these States.

The experience in California has shown also that even the longer-term convicts can be employed to great advantage by the State in quarrying and crushing stone at one or more central points for use in permanent road building. Stone is being extensively crushed in this way in California at less than half what it costs to do this work with hired labor in other States. The quarries used for this purpose are surrounded by a strong stockade, which also incloses the convict quarters, and the escape of prisoners under such conditions is not greater than that from the State prisons. Such a system is applicable, and could be adopted to advantage in each of the Southern States, except in Mississippi, Louisiana, and perhaps Florida.

The captured, but as yet unconvicted, prisoners who are unable to give bail often constitute a considerable portion of the inmates of Southern county jails, such as are shown in the seventh column of the table here given. Under judicious management and an arrangement involving the mutual consent on the part of the prisoner and the county authorities this addi-

* Yearbook of United States Dept. of Agriculture, 1901.

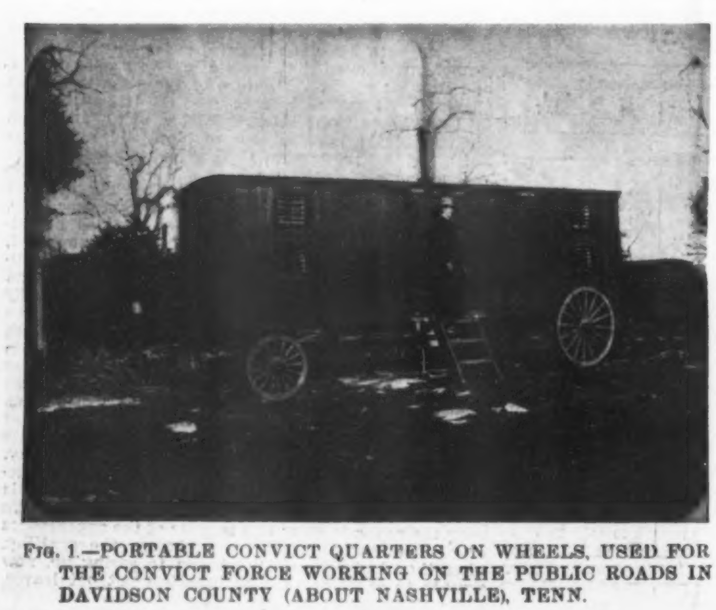


FIG. 1.—PORTABLE CONVICT QUARTERS ON WHEELS, USED FOR THE CONVICT FORCE WORKING ON THE PUBLIC ROADS IN DAVIDSON COUNTY (ABOUT NASHVILLE), TENN.

This arrangement is applicable when a small number of convicts are employed.

FIG. 2.—SLEEPING QUARTERS FOR CONVICTS USED ON THE PUBLIC ROADS IN MECKLENBURG COUNTY, N. C.

This house accommodates 50 persons. Its sides and ends are of boards bolted together in sections. The roof, of corrugated iron, is also in sections, so that the structure can be easily taken down, transported, and set up again. It can also be lengthened or shortened according to number of prisoners to be accommodated.

tional class of prisoners will be found, in large measure, available for highway improvement. This arrangement should provide in each case that when the court's judgment is finally passed, if the prisoner be acquitted, he is to be paid by the authorities a fair compensation for his services already rendered; or if he be convicted, in the carrying out of the sentence of the court the time during which he has already rendered service shall be credited to his account. Under this plan, which has not as yet passed beyond the experimental stage, the acquitted prisoner is set free in possession of a small capital for his support while seeking honorable employment; on the other hand, the prisoner who, for example, five months after his capture, is convicted and sentenced "to the roads" for a period of one year, has, at the time of his sentence already served his country usefully for five months. His sentence will now require of him only seven months additional service before he is set free.

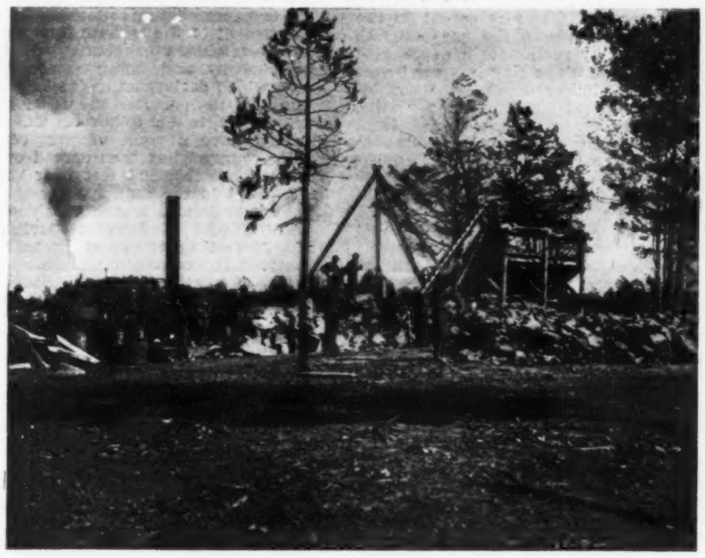


FIG. 4.—CONVICTS OPERATING THE ENGINE AND STONE CRUSHER, USED IN ROAD BUILDING IN MECKLENBURG COUNTY, N. C.

The North Carolina law of 1901, controlling the assignment of convicts for public-road building purposes, is perhaps the most sweeping to be found in any of the Southern States, and may be quoted as follows:

"Section 8. That all prisoners confined in the county jail, under a final sentence of the court for crime, or imprisoned for nonpayment of costs or fines, or under final judgment in cases of bastardy, or under the vagrant acts, all insolvents who shall be imprisoned by any court in said county for nonpayment of costs, and all persons who would otherwise be sentenced in said county to the State prison for a term of less than ten years, shall be worked on the public roads of the county: *Provided*, That in case the number of such persons in any county, at any time, be less than ten, the commissioners of the county may arrange with the commissioners of any neighboring county or counties for such exchange of prisoners, during alternate months or years, as will enable each such co-operating county to thereby increase the number of prisoners at work on the public roads at any given time. And upon application of the said road superintendent of the county, or that of the chairman of the board of county commissioners, the judge of the superior court, or the judge of the criminal court, the justices of the peace and the principal officer of any municipal or any other inferior court, it shall be the duty of the said judge or justice of the peace, or said principal officer, to assign such persons convicted in his court to said road superintendent or road supervisor in any township making provision for the same, for work on the public roads of said county or township; all such convicts to be fed, clothed, and otherwise cared for at the expense of the county or township, as the case may be: *Provided further*, That in case of serious physical disability, certified by the county physician, persons convicted in said superior, criminal, or inferior court may be sentenced to the penitentiary or the county jail.

"Section 9. That when the commissioners of any county shall have made provisions for the expense of supporting and guarding, while at work on the public roads of the county, or any township thereof, a larger number of prisoners than can be supplied from that county, upon application of the commissioners of said county to the judges of the superior and criminal courts, the justices of the peace and the principal officers of any municipal or other inferior court presiding in any other county or counties which do not otherwise provide for the working of their own convicts upon their own public roads, shall sentence such able-bodied male prisoners as are described in section 8 of this act from such other counties to work on the public roads of said county or townships applying for the same, in the order of their application; and the cost of transporting, guarding, and maintaining such prisoners as may be sent to any such county or township applying for the same shall be paid by the county or township applying for and receiving them out of the road fund of each such county or township: *Provided*, That any and all such prisoners from such other counties may at any time be returned to the keeper of the common jail of such counties, at the expense of the county or township having received and used them."

As a rule, it has not been found economical to work convicts on the public roads when the squad consisted of less than eight or ten men. It is customary to have one guard for each ten or fifteen men, and, of course, this one guard would be necessary even were there only one or two men in the squad. In addition to the guards, there is usually a superintendent of the work; consequently this work is carried on most efficiently when the road force or camp contains from thirty to fifty men. When the number of convicts to be employed on the roads in any county is more than fifty or sixty, it has been found better to divide the force into two squads or camps, each having its own local superintendent and guards, and both squads managed under the general supervision of the county superintendent of roads, he in turn being responsible to the county court or board of county commissioners.

It is usually urged against this system of road building that it offers too many opportunities for the escape of prisoners. Experience in many counties, however, has shown that the average annual escapes amount to less than 2 per cent, and the few who do escape are usually recaptured within a day or two. Often the prisoners assigned to the roads are men who live in the community and have families and some property there, and consequently do not care to leave permanently; hence they rarely attempt to escape. Such prisoners as show a desire to escape or who, in the judgment of the superintendent, are men liable to make an effort in that direction, are usually required to carry a ball and chain, which, while it makes it impossible for the prisoner to run rapidly, does not seriously hamper his movements in the regular road work. On the other hand, the convict who does his work faithfully and shows himself worthy is often rewarded by receiving generous treatment.

Morning and evening the prisoners are marched along the road from and to their temporary quarters, which consists usually of either heavy, large tents, portable houses on wheels (Fig. 1), or structures either of wood or corrugated iron, built in sections so that they can be easily taken to pieces, removed, and set up again (Fig. 2). In order to facilitate their being safely guarded during the night without great risk and expense, each prisoner, when he goes to bed, has either one foot or one hand fastened loosely to a chain or rod, from which he can be easily released the following morning. The beds or bunks for these prisoners are easily and cheaply made comfortable, and the comfort of their temporary quarters is improved during the summer by ample ventilation and during the winter by the use of stoves.

The cooking and washing at the camps is usually done by some trusty male convicts, especially experienced in these directions, or by the female prisoners, or in still other cases by hired labor. The carrying of water, along with other similar errands, is usually assigned to the younger prisoners, or such as may not be sufficiently strong for the regular work on the roads. Isolated jobs are usually assigned to certain prisoners who, from their associations and generally good characters, are considered safe for carrying on such work without the immediate supervision of guards, and such prisoners are commonly known as the "trusties" of the camp.

The work of road building is usually extended to a distance of one or one and one-half miles in each direction from the camp, and the camp is then moved a sufficient distance, so that two or three miles of additional road may be built before a second removal becomes necessary. The work done by these convict road builders includes almost every variety of manual labor necessary in this connection. Thus, in counties like Mecklenburg, N. C., where considerable efficiency has been reached in macadamizing, they drive the teams, handle the shovels and picks, ride the road machines, quarry stone, run the engines, and operate the stone crushers (Fig. 4), and occasionally the great steam rollers. They spread the gravel or broken stone (Fig. 5), and in still other counties they mix the sand and gravel or clay, and give shape to the road surface.

The cost of convict labor in road building, as might be expected, varies greatly with the effciency or inefficiency of the management and the number of prisoners employed in any squad. The cost per convict per day in this work, including the cost of his food, tobacco, clothing, washing, medical attendance, and guarding, as reported for the year 1900 from representative counties in each of the several Southern States, is given here:

*Cost of labor per convict per day in road work.**

Florida	$0.30	to	$0.50
Georgia	.16	to	.32
Kentucky	.50	to	.60
Louisiana	.50	to	.60
Mississippi	.15	to	.45
North Carolina	.15	to	.40
South Carolina	.17	to	.22
Tennessee	.20	to	.40
Texas	.20	to	.40
Virginia	.25	to	.50

A comparison of the figures given with similar figures for hired labor shows that the cost of convict labor in several States ranges from one-third to one-half that of the hired labor employed on the public

* The figures for Alabama and Arkansas are omitted, owing to the probability that certain expenses connected with the maintenance of the teams have been, by mistake, included in the figures reported from these States.

FIG. 5.—CONVICTS BUILDING A MACADAM ROAD IN MECKLENBURG COUNTY, N. C.

FIG. 6.—DOUBLE TRACK MACADAM AND EARTH ROAD, BUILT BY CONVICT LABOR IN MECKLENBURG COUNTY, N. C.

roads in those States. In the two Carolinas and Georgia, where the road work is carried on with great efficiency, the cost of maintaining and guarding the convicts at work on the public roads ranges in many counties from 20 to 30 cents per convict per day, and is even considerably less than the cost of feeding them in the county jail. In explanation of this fact, it may be said that during the stay of convicts in the county jail the jailor is paid so much per day for feeding and caring for each; but that while they are employed on the public roads provisions are purchased at wholesale and competitive rates; that the convicts do their own cooking and washing; and that, owing to the usually healthy condition of the convict camps, the cost of medical attendance is almost nothing.

As to the efficacy of convict labor on the public roads, compared with that of ordinary labor, the general testimony from the many counties in the Southern States is highly in its favor. It must be borne in mind in this connection, however, that the hired labor which can be secured in the Southern States for work on the public roads does not belong to the most efficient class, and also that it cannot be easily held longer than a few days or a few weeks at a time; consequently, it is often unsatisfactory. In the case of convict labor, on the other hand, the labor is entirely under the control of the guard and superintendent, and, especially in the case of long-term prisoners, it can be managed so as to reach a considerable degree of efficiency, both in ordinary work and in the handling of road-building machinery. Convicts thus not only make fairly efficient laborers while engaged in this work, but receive that training and experience which enable them to earn a better living, and hence become better citizens after the expiration of their terms of service.

It has been, therefore, the general verdict from the various counties in the Southern States where convict labor is employed in road building to any considerable extent, that in both efficiency and cheapness it is decidedly superior to such free labor as is ordinarily available there for this work.

It is often urged against this mode of employing convict labor, that the very publicity of the work in exposing the prisoner to the view and to the remarks of the travelers along the highway would have a tendency to harden the criminal and make him less amenable to other beneficent influences. But careful inquiry concerning this point, made in many counties, has failed to elicit evidence in favor of this supposition. On the other hand, a considerable amount of evidence has been collected which goes to show that this out-of-door work not only improves the physical health of the convicts, but that their experiences as road builders have actually improved their general character and prepared them for better citizenship. Moreover, there are in these different States hundreds of cases where prisoners connected with the road camps have behaved themselves properly and labored efficiently, have been trained and trusted by their superiors, and have secured at the expiration of their terms of sentence fair positions in or near the communities where they had previously lived.

It is, of course, as true of convicts as it is of other persons, that fair and just treatment by superiors tends to develop the better qualities, whereas harsh and unfair treatment tends to develop the meaner side of their nature, and the latter treatment should never be permitted. As a rule, the treatment of the prisoners at the various road camps in the Southern States is fairly humane, though there is need of improvement along this line. Religious services are usually provided for them on Sundays, and an earnest effort is made to develop these convicts into better men as well as more efficient laborers. There are, of course, some exceptions to this, and it should be the constant purpose on the part of those in authority to see that these exceptions disappear. While a convict must be punished as he deserves, he must also always be treated with that uniform kindness and fairness which lead him, even as a prisoner, to realize that justice prevails, and that it pays to do right.

Every effort should be made by the proper authorities to educate a prisoner to a realization of his indebtedness to society (especially to some particular community) and the justness of his punishment. The acknowledgment and fulfillment of this obligation on the part of a criminal should be as helpful to his character as is the payment of an honest debt helpful to the character of an ordinary citizen. The circumvention of justice has an injurious influence as well in the one case as in the other.

The nature and extent of the work done by convict labor in the improvement of highways in the Southern States can be best illustrated by a brief statement of what has been accomplished in a few counties selected out of a large number that have adopted this system.

Prior to the year 1879 the public roads of Richmond County, Ga., were in a state of neglect. Over a portion of them the surface was a deep sand, the dread of all travelers during dry weather, while the surface of the other portion was of clay, which became a quagmire during the rainy season. Meanwhile the authorities were at a loss to know what to do with their county prisoners, and the lack of a definite policy in this regard resulted either in keeping all the prisoners in the county jail, at considerable expense, or else employing them at miscellaneous jobs about the city of Augusta, the county seat. In January, 1879, the county judge inaugurated a definite policy for the improvement of the public highways of the county, and placed every available county prisoner at work with a view to the accomplishment of this end.

The work of improving and keeping in repair 350 miles of public roads and 3 miles of bridges was begun with a force of thirty prisoners and ten mules, and with funds but little more than sufficient to maintain this force upon an economical basis. Fortunately, the work has been pushed continuously to the present date. While naturally these efforts at first met with considerable opposition, the results have proved so eminently satisfactory to the people of the entire county that to-day the system meets with practically unanimous support.

The first work undertaken was the grading and draining of the roads. This was followed by the spreading of a few inches of sand over the clay roads and a few inches of clay over the sandy roads, the cost of this work being but little more than the expense of the labor and hauling, as the material was usually found close at hand. For the country roads where the traffic was light, the surface prepared in this way proved eminently satisfactory, often requiring little or no repairing for several years. On the main thoroughfares, nearer the city, where the traffic was heavier, the sand-clay surface proved less satisfactory, and it was found advisable to spread a layer of gravel on top of it. These roads have a width of 30 feet, and the gravel has been spread over the center to a depth of from 6 to 8 inches, for a width of 20 feet near the city and 16 feet farther out in the county. On the sand-clay roads in the one case the sand is spread over the clay surface to a depth of 2 to 6 inches; in the other case the clay is spread over the sandy surfaces to a similar depth. The cost of the gravel roads has averaged about $1,600 per mile, while that of the sand-clay roads has ranged from $100 to $500 per mile, this variation being due to the amount of grading to be done and the nature of the materials used, and the distance it was necessary to haul them. The force at work on these roads at the present time consists of one hundred convicts, thirty-two head of stock, and a thorough equipment of machinery.

As a result of this well-directed policy, there are now in Richmond County 100 miles of sand-clay roads and 100 miles of gravel roads, all well graded and drained. The old wooden culverts have been replaced by larger ones of brick and smaller ones of vitrified pipe, and the old wooden bridges are being replaced by more modern structures of iron and steel. This accomplishment is the result of a well-directed continuous policy inaugurated and pushed by an intelligent, determined public official, whose efforts have deservedly won and now continuously receive the support of an intelligent public opinion.

The sand-clay roads in Richland County, S. C., are worthy of special consideration, not only as a product of convict labor, but also as an illustration of how much may be accomplished in many localities in highway improvement at small cost, by treating the road surface with a simple admixture of sand and clay. This county, with Columbia as its county seat, is located where the hill country merges into the lowlands, and where the beds of coarse sand and clay are in close proximity. After constructing 2½ miles of ordinary macadam road, at a cost of from $2,000 to $3,000 per mile, the county supervisor (who in all South Carolina counties has charge of the public roads) wisely decided to try the simpler and cheaper plan of spreading sand over the clay roads and clay over the deep sandy roads, and he has carried forward this work to an extent and a degree of efficiency perhaps equaled nowhere else in the neighboring States. It was not easy to determine the amount of sand in the one case, or of clay in the other, which would give the best final result. Consequently, it has been necessary to watch the resulting road surface for several months, in some cases adding more sand where the surfaces showed a tendency to give way under traffic in wet weather, or in other cases adding more clay where the tendency was for the surface to break up during the dry season. First, the roads were cut to a grade of from 2 to 3 per cent, then the surface was given the proper cross section for shedding water, this surface slope being kept sufficiently gentle to permit the water to run off slowly and not to carry the sand with it. The clay or sand was then hauled in wagons or carts, usually short distances, and spread over this surface for a thickness of from 2 to 6 inches. The mixing of the sand and clay was done by the ordinary travel, which was never stopped, and the surface was finally packed by the wide-tire wagons and carts or a horse roller. Where the supply of sand needed for spreading over the clay road is not found near by, pockets are made in the ditches for catching sand, which is later taken out and spread over the surface.

This work has been in progress during the past four years. Everything, even to the construction of the culverts and smaller bridges, except the guarding and supervision, has been done by convict labor. The size of the force has varied from forty to seventy prisoners, whose terms of sentence ranged from a few days to five years. During the year 1901 there has been an average of sixty persons, divided into two camps. The cost of their maintenance, including the guarding, feeding, clothing, and medical attendance during the year, has averaged 20 cents per convict a day, as compared with a cost of 30 cents per day per prisoner for feeding and guarding while confined in the county jail prior to sentence and assignment to the road force.

As a result of this work during the past four years this county now has (out of a total of about 650 miles of public roads) about 125 miles of improved sand-clay roads, 25 to 30 feet wide, which cost for grading and surfacing about $300 per mile, and 75 miles of similar roads, which, built under more favorable conditions, cost about $200 per mile. In a few places, where the materials were close at hand and little grading was necessary, it is said that this work has been done at a cost not exceeding $150 per mile. The oldest portions of these roads have borne the traffic of three winters and three summers in a highly satisfactory manner, and the annual cost of repairs has not exceeded $10 per mile.

It would be a manifest error to suppose that similarly cheap and satisfactory sand-clay roads can be built in all other portions of the coastal plain region of the South Atlantic and Gulf States, for it must be borne in mind that the character and distribution of the sand and clay deposits of Richland County make the road-building conditions there exceptionally favorable, and the management of the work has been very efficient. But the success in this county and the measure of success which has followed experiments on a smaller scale in other less-favored localities, certainly suggests a line of policy and experiment which promises cheap and fairly satisfactory results at small cost over much of the area of the South Atlantic and Gulf States.

Modern road building in Shelby County, Tenn., began about fifteen years ago with the construction of the gravel turnpikes which now radiate from Memphis, the county seat, toward the north, east, and south. Since that time the county has built some 350 miles of these excellent turnpikes, and is said to have expended in their construction and maintenance approximately $800,000. The grading for these roads has been done largely by the county convict force (Fig. 3); but the larger part of the quarrying, hauling, and spreading of the gravel has been done by hired labor under the contract system, only a limited portion of this work having been done by the convicts.

The management of these roads is vested in a turnpike commission consisting of three members, with the chairman of the county court as its head. The management of the convict force is vested in a workhouse commission or board, both commissions being appointed by and being responsible to the county court, which decides as to the tax to be levied for the support of the convicts and the general road-improvement policy to be followed. The turnpikes as constructed have a right of way of 50 feet. On this roadway gravel has been spread over its central portion to a width of 14 feet near the city and 12 feet farther out in the country.

The gravel used in the construction of these turnpikes is found in deposits varying from 5 to more than 20 feet in thickness in many portions of the county. It consists mainly of small, well-rounded pebbles of quartz, chert, and flint, cemented together with oxide of iron and a limited amount of clay. When these beds are broken down by blasting, and this gravel is spread on the road with care, so as not to separate from the pebbles the cemented material, it re-forms a hard, firm surface, which makes an excellent roadway. Where the distance does not exceed 2 or 3 miles, it is hauled by wagons from the pits to the road, but for longer distances it is hauled by rail to the nearest station, whence it is carried by wagons to the roads on which it is to be spread. Large quantities of the gravel used have been hauled by rail for a distance of more than 100 miles.

These gravel deposits are usually owned by private individuals, and the road authorities pay for it at the pit from $2 to $3 per car of 14 cubic yards. When spread over the roads for a thickness of from 6 to 8 inches, it has usually cost from $1,000 to $2,000 per mile.

The convict force during the year 1901 has included from 120 to 140 men, of which from 80 to 100 have been employed on public roads during the months of May to November. During this work season the prisoners have occupied temporary quarters in the country, traveling each day a distance of from 1 to 5 miles to and from their work. During the winter season, from November to April, the entire force of convicts are kept in their permanent quarters on the workhouse farm near the city, being used partly for farm work and partly for road and street improvements near by. The cost of employing these convicts on the public road is said to average about 40 cents per day per prisoner. The force has already rendered a most important service to the county by helping in the construction of its present turnpikes; but there will doubtless be a decided improvement, both in the efficiency and economy of operating this convict force for road-building purposes, when the management is the same as that for the turnpikes, and when a better system of movable stockades or quarters is adopted, so that the prisoners may camp at night near to their place of work, and continue their road-building operations throughout the entire year.

Modern road building in Mecklenburg County, N. C., and indeed modern road building in the State of North Carolina, may be said to have begun with the adoption of road laws nearly twenty-five years ago, which authorized each township in the county to levy a special tax for the maintenance and repair of its public roads, and permitted the commissioners to levy a special tax for the support of its convict labor in the permanent improvement of the county highways. This work has now been in progress for two decades on an increasingly large scale and with growing efficiency. At the present time this county maintains in connection with its public-road work two convict camps of from fifty to sixty prisoners each (Fig. 2).

The road-building equipment at each of these camps includes a quarrying outfit, a steam road roller, a stone crusher and engine, a road machine, scrapers, carts, wagons, mules, shovels, picks, etc. In the management of these convicts there is a guard for each ten or fifteen prisoners and a local superintendent who has charge of the camp and the road work done by it. The entire road work of the county, including the management of both these convict camps, is under the control of the county superintendent of roads, who is also an engineer, and who reports monthly, and oftener if need be, to the board of county commissioners, which board decides upon the amount of road tax to be levied each year and exercises general control over the work.

The county being situated in the hill country, the old roads with their steep grades have had to be relocated at certain points, and they have been graded by cutting through hills and building up intervening depressions until this grade work as seen to-day resembles that along a railway line (Figs. 5 and 6). These roads radiate out from Charlotte, the county seat. They have a width in the central township of 40 feet, of which 12 feet in the center has been macadamized, and a dirt road has been arranged on each side of this. In the rural portions of the county the width of the road has been contracted to 30 or 35 feet; the macadam track has in many cases been reduced to a width of 10 feet, and has been placed on one side of the road. This gives a double track—one, the macadam, to be used almost exclusively during the rainy season, and the other, the earth road, to be used generally during dry weather. This double-track system, which is much preferred by the farmers, prolongs the life of the macadam road by relieving it from traffic during dry weather (Figs. 5 and 6).

All of this work is being done by convict labor, and the long period (five to ten years) for which many of the prisoners have been sentenced permits their being trained for expert work in the way of handling machinery and grading and macadamizing the roads. In connection with the cost of this work, it may be added that the maintenance of the convict force (including salaries of the guards and camp superintendent, and the clothing, board, tobacco, and medical attendance for the convicts) averages for the entire force for the year from 28 to 30 cents per convict per day. These convicts are housed throughout the year in comfortable portable structures, made of wood and corrugated iron, framed in sections, so that they are easily taken down and moved by a small portion of the squad from one point to another along the road (Fig. 2).

During the past twenty years, and largely during the past decade, 104 miles of such macadam roads have been constructed in Mecklenburg County by convict labor. At first, as might be expected, the progress made was slow and the work not always well directed, but year by year the county authorities have profited by their own experience and that of others, and during the past few years there has been a decided improvement both in the rate of progress and efficiency of management. During the year 1901, 12 miles of road have been graded and macadamized, at a cost ranging from $2,000 to $3,500 per mile, including the grading and macadamizing, the construction of culverts and abutments, and the materials for new bridges. The county is now expending annually something more than $40,000 on the improvement of its highways; and the proposition that this expenditure is the best-paying investment the county could possibly make is accepted by every class of citizens, and even by the convicts themselves, who seem to feel a genuine pride in the excellent highways they are building.

THE ELECTRIC MOTOR.

ITS USE IN MODERN BLAST-FURNACE PLANTS.

By A. E. MACCOUN.

In the large blast-furnace plants of to-day electricity is gradually taking a very important part in the economical operation of all labor-saving devices for handling raw materials, such as ore, coke, and limestone.

This is largely due to the great convenience and economy in transmitting it, the ease and convenience of control, and the great economy over uneconomical steam engines which is effected by its use.

Most of the power houses for these plants have their steam boilers supplied by the waste blast gases, no additional fuel being required; the bosh water which is circulated around the tuyeres and cooling plates of the furnaces can be used as condensing water, so that power can be generated very economically, as the power plants for this purpose generally use compound condensing engines of good steam economy.

Large electric ore bridges are used in the stock yards of these furnaces for handling all the raw materials, and these operate in the cheapest possible way, unloading and storing it in the stock yards, so that large supplies of all the different grades of ore can be kept on hand. As the furnaces require the different ores, grab buckets on the bridges take it from the piles and dump it in the ore bins ready for use in the furnaces.

Electric car dumpers also are being used extensively for dumping the railroad cars in which the ore and other raw materials are received into smaller cars more suitable for being unloaded from the ore bridges into the stock yards; electric locomotives are used for shifting these cars, and in many places they are also used for shifting the railroad cars in which the ore, coke, and limestone are received, over the bunkers for direct use on the furnaces. These electric locomotives are much more economical than the steam shifting locomotive, and much fewer repairs are required on them. Small electric cars are also used extensively for delivering the raw materials from the ore, coke, and limestone bunkers directly to the furnace skips.

The labor for handling these raw materials has been reduced to such an extent by these labor-saving devices that it is surprising to see how few men are required in the stock yards of the modern furnace plants where such enormous quantities of raw material are continually being handled.

Motors are also used to advantage in running pig machines. These consist of endless conveyers, with molds in the shape of an iron pig, into which the molten iron is poured and cast into pigs, which fall from the conveyers into cars ready for shipment; these machines have saved much hard labor around blast furnaces which formerly required large cast-houses attached to them, in which the iron could be run into molds; but now it is run from the furnace directly into ladles, and if it is not to be converted directly into steel it is poured on the pig machine and cast into iron pigs.

In all work of this class scattered over large areas the electric motor is by far the most economical thing to use; outside of its gain in economy over the steam engine, the condensation in long steam lines is avoided; and often small boiler plants have been done away with, and labor, fuel and repairs have been saved. And as the electric motor requires very little attention it can be readily seen what enormous savings are effected by its use in such places.

Electric hoists are also gradually coming into use for hoisting the raw material to large furnaces; these, with the modern skip equipments, save top fillers on the furnaces, and also are much more economical than the steam engine used for this purpose.

I will mention a few of the advantages gained by the use of electric hoists, and will make a few comparisons between the hoists operated by steam and by electricity.

The modern skip equipments are made very much larger than the old-style hoists, lifting from five to ten tons of raw material at from 250 to 500 feet per minute. With large furnaces this is very important, for at times when a furnace is running badly it is very important to fill it quickly, thus not allowing the burden to get very far out of reach; but with the older style elevator, which took up two barrows or so at a time, it took a long time to fill a furnace in this condition, and furnaces always work much better when such irregularities are avoided.

The electric hoist can be made to stop at exactly the same point in its travel, independent of the load carried. This is done by means of series of magnets that control switches arranged to cut in more resistance, when the motor starts to slow down near the end of its travel, on the light loads than on the heavy loads. By adjusting these magnets, the hoists can be made to stop at any point, independent of the load carried.

In addition to the great steam consumption of the steam hoist there is a far greater loss due to the condensation going on in the long steam lines that generally run to these hoists, and in the exposed valve chests of the engines. These losses in twenty-four hours are considerable, and there are always more or less leaks in steam lines of this character; besides this, there are often long intervals during which the engine stands idle—yet all these losses are continually going on. There is also a great quantity of cylinder oil and engine oil and packing continually being used by the steam hoist. These items amount to a great deal during a year; but with the electric hoist the bearings are self-oiling and use very little oil, and require very little attention. At some works where these hoists are used the man that runs the hoist also weighs the ore and limestone, and operates the bells on the furnace, the hoist being entirely automatic after it is first started.

From actual tests on one of these furnaces the average efficiency (the ratio between the theoretical mechanical horse power required to lift the material and the electrical horse power taken by the motor) is approximately 61 per cent, when the efficiency is averaged with all the different loads, such as ore, coke, and limestone. This efficiency takes into account all the losses in motor and gearing, friction of skips on tracks, and is the average of a great number taken from all the different loads.

An additional test was also made from wattmeter readings, the wattmeter being very carefully calibrated.

The wattmeter readings were taken for two weeks on a line on which there were three blast furnaces; two of the above furnaces were identical in size; the third was smaller.

48 horse power was the average power consumed by these furnaces during this period.

11 horse power was the part of this power estimated as used by the small furnace.

18.5 horse power was the power consumed by each of the large furnaces.

Ten thousand tons of raw material was the approximate amount lifted to each of the larger furnaces each week during this period, and 135 feet was the height the material was lifted.

9.1 horse power was the average theoretical horse power required to lift this material to one of the larger furnaces during this time.

Fifty per cent is the approximate efficiency or ratio between the power used at switchboard in power house, as shown by the wattmeter, and the theoretical horse power required. This takes into account all losses in lines, motors, gearing, friction of ropes, drums, sheaves, and extra trips when no load is carried, and movements made for lifting scrap.

If an electrical horse power hour is generated at switchboard in power house for 20 pounds of steam, then taking all losses into consideration it takes 40 pounds of steam per horse-power hour to do the actual lifting at the hoist.

If the value of an electrical horse power for a year at the switchboard is placed at $50, the cost of power for one year at one of the larger furnaces would be approximately $925; at this rate, therefore, the cost of power for lifting 100 tons of material 135 feet would be 17.8 cents, and the cost of lifting one ton of material the same height would be 1-6th of a cent. There are very few steam hoists at blast furnace plants that will do this work for one cent per ton.

This shows plainly in one instance the great economy effected by the use of the electric motor on furnace hoists, and this is only one of the smallest savings, because, as a usual thing, in other classes of work there are great savings in labor besides the savings in power, and at times one man can be put to manipulate the same number of motors where formerly it took two or three men when engines were used.

These facts show how the use of electricity is being developed about steel works and blast furnaces, and there are many of these works that have over 10,000 horse power of motors of various sizes for work of this kind, and there are gradually increasing applications of electricity to many other classes of work.—Boston Journal of Commerce.

CONTEMPORARY ELECTRICAL SCIENCE.*

INDUCED RADIO-ACTIVITY.—A. Sella has found that a temporary radio-activity can be imparted to a spiral spring by means of a charged rod placed in its axis and provided with needle points. The most remarkable circumstance observed was that the spring, and indeed any metallic body exposed to the "effluvium" from an influence machine, may thus be made radioactive even if positively charged. The amount of radio-activity acquired depends largely upon the state of the atmosphere, and is largest in a room closed for some time, but is independent of the nature of the metal. It is not obtained in an atmosphere of oxygen or coal gas, nor in a small confined space, unless some thorium oxide or other radio-active body is introduced into it. In that case the radio-activity acquired is great, but is the same whether the body is charged positively or negatively. On renewing the air, however, the negative radio-activity is much the greater. The author also describes some figures resembling Kundt's dust figures obtained by the effluvia from three points close together. He mentions that he has succeeded in making metallic electrodes strongly radioactive by using them to electrolyze a solution of thorium nitrate. "Auer's solution" with some nitric acid is very suitable. This radio-activity is also temporary.—A. Sella, Nuovo Cimento, August, 1902.

* Compiled by E. E. Fournier d'Albe in the Electrician.

LENGTH AND RESISTANCE OF NICKEL.—W. E. Williams brings out graphically a remarkable parallelism between the change of length of a nickel wire in a magnetic field and its change of resistance in the same field. Both changes were measured in the same piece of wire, as nearly as possible at the same time and under the same conditions. The experiments were made on a nickel wire 0.12 mm. in diameter and 80 cm. long. The Japanese physicists have already shown that there is no apparent connection between the change of resistance and the magnetic change of length in iron. In that metal, there is a change of sign in the length from low to high fields, while there is no such change of sign in the resistance. The Welsh work before us shows, on the other hand, a remarkable agreement in the curves for resistance and contraction in nickel. The curves are almost identical for loads of 50, 100, and 500 grammes. At 700 grammes, the change of length curve intersects the resistance curve twice, but the general direction is the same. At very low fields there is a certain discrepancy, and this the author connects with the Villari reversal shown by nickel at very low fields. The Villari effect in iron occurs at much higher fields, and hence iron does not show the connection described.—W. E. Williams, Phil. Mag., October, 1902.

RESONANCE OF METAL PARTICLES FOR LIGHT WAVES.—R. W. Wood has shown that granular deposits of the alkali metals exhibit brilliant colors by transmitted light. He now believes that these colors are identical with those observed by Threlfall in metallic precipitates. It was found that the immersion of the particles in a liquid of high dielectric constant produced striking changes in the color of the transmitted light, the change corresponding to a shift in the absorption band toward the red end of the spectrum. Aschkinass and Schaefer have shown that the length of electromagnetic waves to which a system of metallic resonators respond, is increased by immersing the resonator system in a liquid of high dielectric constant, which is obviously analogous to the behavior of the sodium and potassium films. The author's recent investigations have convinced him that it is impossible to refer the colors either to interference or diffraction, and it remains only to determine whether the resonance of the metal films is molecular, as in the case of the aniline dyes whose absorption band depends on the dielectric constant of the dissolving medium, or whether we are dealing with an electrical vibration of metallic masses smaller than the light waves, though of the same order of magnitude. The author has now produced films of gold and silver, and is studying their dispersion.—R. W. Wood, Phil. Mag., October, 1902.

ATOMIC WEIGHTS.—G. J. Stoney makes an interesting forecast in connection with the diagram of atomic weights he published in 1888. In that diagram the elements were arranged on a logarithmic spiral, and elements of similar nature usually occurred on the same radius. The elements lithium, potassium, rubidium and caesium occurred on the same radius, and were then considered to have the greatest atomic volumes. That radius was designated "sesqui-radius 1." The author now points out that the distinction of the greatest atomic volume in the solid state will probably have to be shifted to sesqui-radius 16, on which are situated the new elements helium 4, argon 39.6, krypton 81 and xenon 127. To ascertain by experiment whether this is so in the case of helium would probably overtax the most refined methods of low-temperature research yet known. But it ought to be possible to determine the specific gravity in the solid state of xenon, krypton, argon and neon (20), and if the forecast is found to be correct in regard to these four elements its fulfillment will add strength to the evidence that the physical properties of the elements are the result of general laws. Of such laws there are most probably two—one controlling the elements of even atomicity, and the other controlling the elements of odd atomicity.—G. J. Stoney, [illegible] October, 1902.

WEATHER SHOOTING.—The [illegible] a preventive against hails[illegible] 18th century, when it was [illegible] Bavaria and France, where [illegible] culable damage to the vi[illegible] peror Joseph II. issued an edict [illegible] and in 1811 the Munich Academy of Sciences [illegible] it to be valueless and superstitious. The remarkable success of Albert Stieger, in Styria, in protecting his vineyards against hail since 1896 has stimulated further research, and the practice has been resumed, especially in Italy. H. T. Simon connects the effect with the formation of unstable temperature conditions and their timely readjustment by the shock of the shooting. A steep temperature gradient brings about the sudden exchange between the warmer strata of air below and the colder ones above. The ascent of the warmer strata leads to undercooling; the icicles fall through the undercooled stratum and precipitate further moisture, eventually reaching the ground as hail. The shooting may act by the sound-wave, by the impact of the air vortex, or by the upward projection of dust or ions serving as concentration nuclei. In any case it hinders the formation of the unstable temperature condition described, and allows the condensed moisture to fall to the ground as harmless rain.—H. T. Simon, Jahresber. Phys. Verein Frankfurt, 1902.

METALLIC FILMS OBTAINED BY CATHODE PROJECTION.—Metallic films of platinum, palladium, iron, nickel, cobalt, copper, or bismuth may be obtained on glass and other substances by cathode projection, and the method has already received practical application in America for the production of mirrors and resistances. According to L. Houllevigne the best method is to place the plate which is to receive the film upon the anode, and mount the cathode above it in such a manner that at a pressure of a few hundredths of a millimeter the dark cathode space just touches the plate. The current first of all clears the cathode of occluded gases. This first process is particularly long in platinum, and especially in palladium. Then the substance of the cathode itself is projected and deposited partly upon the glass plate and partly upon the anode. The

deposits may present all degrees of transparency and opacity accordingly as to whether the operation is continued for hours or for days. Bismuth so deposited does not show any change of resistance in a magnetic field, and is, therefore, probably perfectly amorphous. Iron shows magnetic rotatory polarization, but the author has not been able to find the double refraction announced by Righi.—L. Houllevigne, Comptes Rendus, October 20, 1902.

THE NAVAL WAR GAME BETWEEN THE UNITED STATES AND GERMANY.—X.*

By Fred T. Jane.

TORPEDO ATTACK ON THE GERMAN FLEET AT KIAO CHAU.

The next night but one after the events recorded in the last installment the American torpedo division, now raised to four destroyers and two first-class torpedo boats, made an attempt on the German fleet in Kiao Chau.

To tempt such an attack was part of the German programme, and full preparations had been made against it. To annihilate the American torpedo force meant much in the way of equalizing things.

It does not, however, follow that the American attack was foolish. The American players had been clearly given to understand that the umpires would not allow the United States torpedo craft to keep the sea indefinitely off a hostile coast; there was further the prospect that the first rough day would see the German fleet come out, easily able to disregard the boats. Finally, the rival fleets were very equally matched. The destruction of a single German battleship would have left the Americans in a position of definite superiority. After a careful consideration of these points, an attack was decided on. As the Germans had no torpedo nets, there was some promise of success.

The attack was, however, an utter failure. In addition to the land batteries there was a boom well inward. Outside of this boom were gunboats, one of which was torpedoed. The whole attacking force was put out of action.

SECOND PARTIAL ACTION OFF KIAO CHAU.

The next day the German fleet came out again.

The following orders against such an event had been issued by the American vice-admiral, whose flag was shifted to the "Ohio":

"The fleet will be divided into two squadrons: (A) the first consisting of the 'Ohio,' 'Maine,' and 'Missouri;' (B) the slower ships 'Alabama' (flag of rear-admiral), 'Kearsarge,' 'Indiana,' and 'Massachusetts.'

"My intention is that these two squadrons are to act independently, the fast lying to the north and the slow to the south (top of diagrams) of the blockading line.

"These squadrons are to maintain a distance of about ten miles apart, until the enemy appears. Both are then to retreat slowly westward, converging slightly, but no junction is to be made and a minimum distance of 10,000 yards or more (as I may direct) preserved.

"My assumption is that the Germans will imagine that we are endeavoring to effect a junction, and that with a view to preventing this, they will try and pass between our two divisions. In such case the B division (slow) is to envelop the head of the German fleet, while my own (A) attacks the tail.

"By this means I hope to force a general action, that otherwise seems likely to be postponed to our disadvantage.

"The picket boats of the squadrons are all to lie well west of the slow division. Toward the end of the action, or at such other time as may seem necessary, they are, at the discretion of the officer in charge of the boats, to close in and torpedo the enemy.

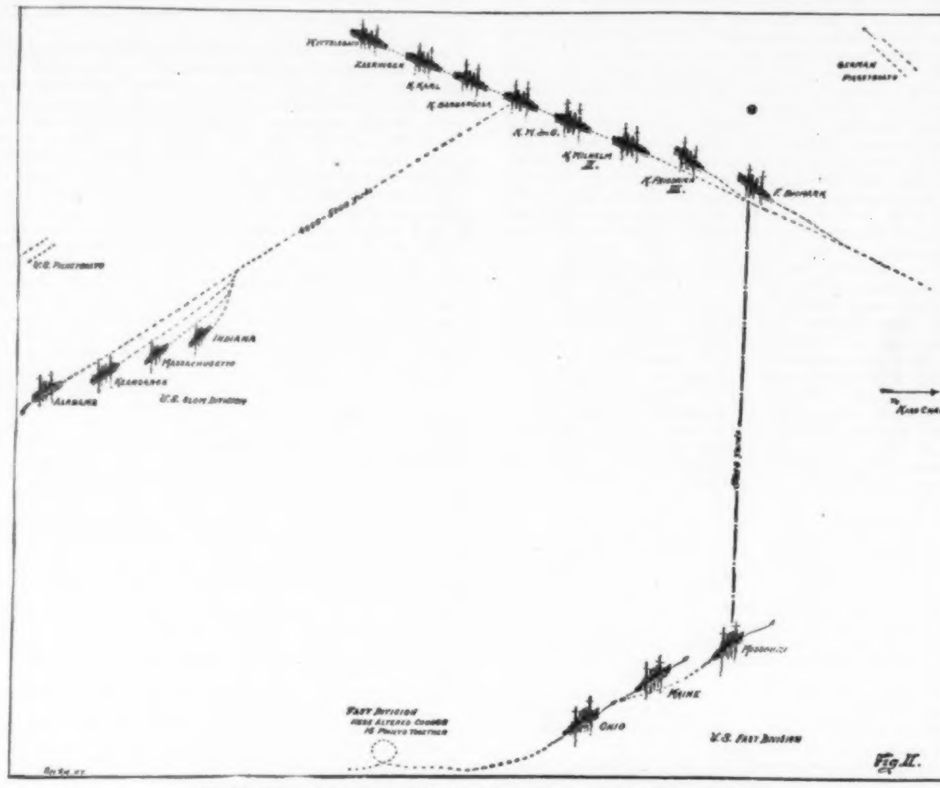
"It is possible that the enemy may, instead of seeking to pass between the slow and fast divisions, attack one only, probably mine. In such case the division attacked is to bear away from the enemy in such formation as may give the best return fire in the circumstances of the case, until the other division has approached sufficiently near for the original plan to be carried out."

Thus the orders of the American vice-admiral, whose tactics, it will be noted by those conversant with tactical theories, were of a French type. The special advantage of these tactics is that they give an appearance of weakness that does not really exist.

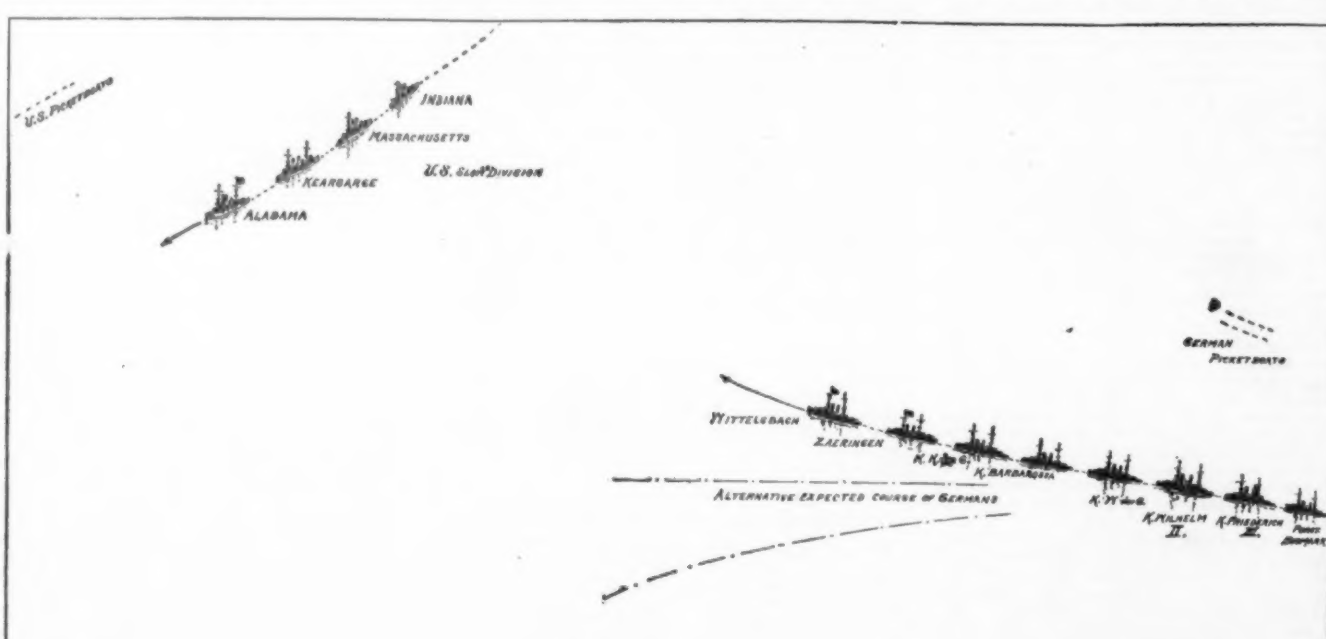
The German fleet came out, with the "Wittelsbach" and "Zaehringen" leading—each flying a vice-admiral's flag. The rest of the ships were arranged in order of speed, the slowest at the tail. They were in single line ahead, and, contrary to anticipation, not only displayed no desire to cut the line, but steered in such fashion that the tail only of the slow American division would be in range of them. The first impression conveyed was that they intended to avoid action altogether. The discovery that the Germans also had their picket boats out dispelled this idea, but for a time their objects were quite undiscernible. They were then (Fig. 2) going at top speed, tailing out. Seeing this, the United States slow division reduced speed slightly, while the fast division, doing its top speed, altered course sixteen points, steering to concentrate on the German rear ships.

The United States rear-admiral signaled that it would be impossible for him to attempt to envelop the German head, at the speed the hostile fleet was

* Prepared especially for the Scientific American by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the Scientific American Supplement of December 20, 1902.



SECOND ACTION OFF KIAO CHAU. SECOND STAGE.



SECOND ACTION OFF KIAO CHAU. FIRST STAGE.

going; plans were then hastily amended, and a concentrated fire ordered on the German rear ships.

The effect of this fire was soon felt by the sternmost German ships, "Kaiser Friedrich III." and "Fuerst Bismarck," but the "Massachusetts" and "Indiana" suffered little less. All four of these ships were badly mauled and dropped out of station.

Then it was that the American vice-admiral signaled: "Delay action; hostile picket boats must be destroyed before battle is engaged."

A chance to cut off the German boats occurred and he—wisely—made the most of it, and finding that the main body of German warships kept on, he signaled for his whole fleet to sink the now separating hostile picket boats. This was eventually accomplished without loss to the Americans, at the expense of a distribution that might have been serious had the Germans suddenly returned.

The German fleet, however, was busy chasing the United States picket boats, and did not destroy these till it was a long way from the field of battle and as divided up as the American fleet.

Meanwhile the four disabled ships (Fig. 3) were closing on each other.

The American vice-admiral signaled to inquire whether his two could settle the two Germans, and receiving a reply in the affirmative, ordered the "Alabama" and "Kearsarge" to join in the attack upon the picket boats—his idea being that these constituted the gravest danger, and that it was beyond all things desirable to keep as many battleships intact as possible.

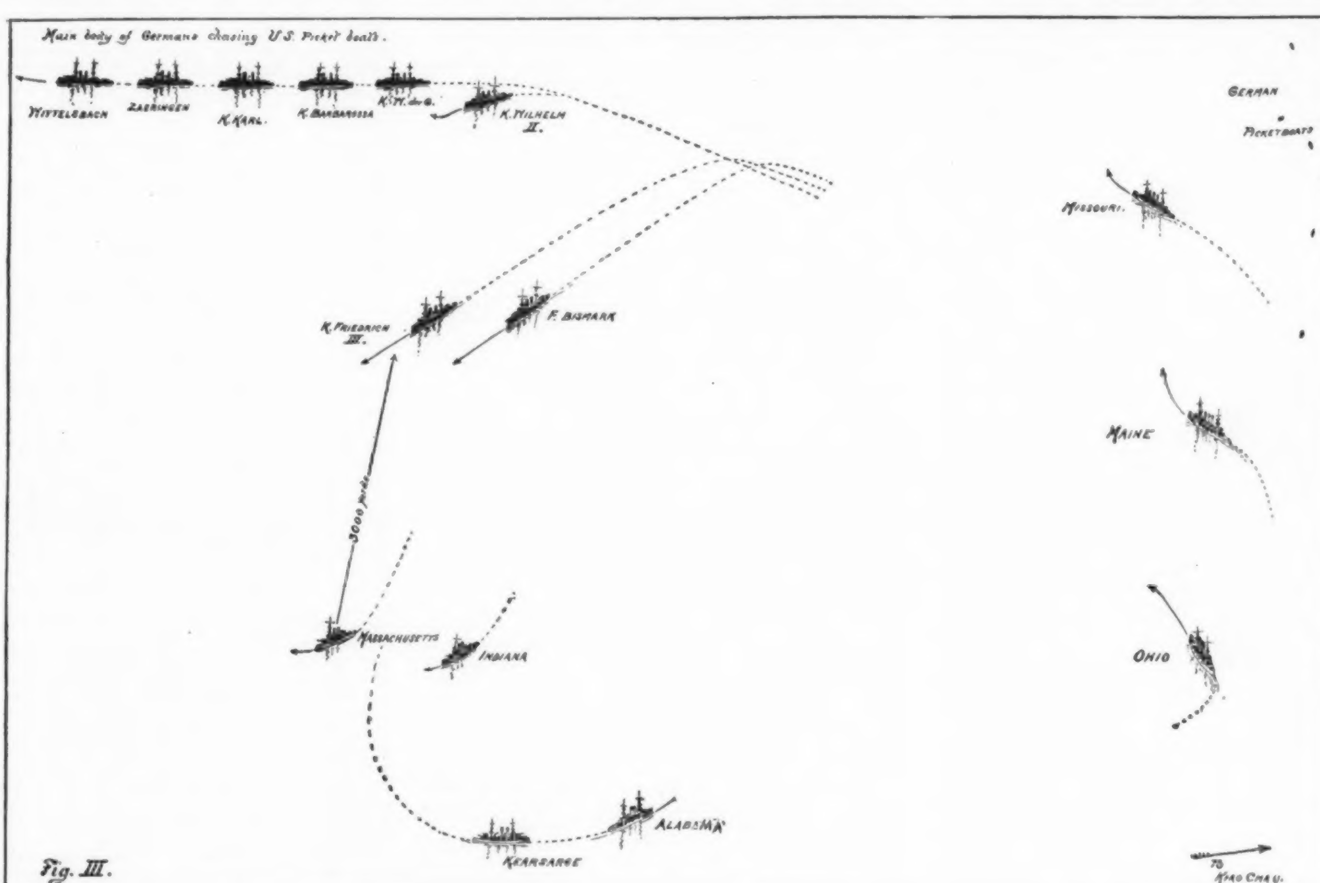
The two German vessels, keeping the disabled Americans between them and the remainder of the United States slow division, closed in, bows on. It was then discovered that they had a superiority of gun fire, and the "Massachusetts" signaled to the "Kearsarge" for immediate assistance. Before this ship could get round with a clear target the Germans had reached torpedo range. The Americans made the better shooting, and practically wiped out all the German bow fire, reducing the attack to dead slow. The torpedo efficiency was not, however, impaired, and the "Indiana" was hit and went down. The returning "Kearsarge" got a broadside into the "Bismarck" that settled her. She then devoted attention to the "Kaiser Friedrich," now coming very close to the "Massachusetts." A torpedo destroyed that ship also—again from the bow submerged tube. Immediately it was seen that the "Massachusetts" was sinking, the "Kaiser Friedrich III." struck, and was taken possession of by the "Kearsarge." She was an absolute wreck, worth next to nothing as a capture.

By the time this incident and the destruction of the German picket boats was over, the main German fleet was hull down, leaving the Americans to surmise as to their next intention.

Already during the "war" the players of American vessels had noticed with dismay the immense superiority of the German vessels in torpedo armament. One American fleet had been lost through the torpedo (see the cruiser action in mid-Atlantic), on other occasions American torpedo inferiority had proved hampering. There was therefore at once a general guess that the Germans would be back with the night, and under cover of the darkness endeavor to secure that victory which superior average speed and superior torpedo armament might promise, and which their inferiority in guns and armor rendered unlikely in a combat confined to those weapons.

This surmise was correct; the German intention was a night torpedo fight.

(To be continued.)



SECOND ACTION OFF KIAO CHAU. THIRD STAGE.

HISTORY OF CENTRAL PARK.

In 1856, the year of its purchase by the city, the land now constituting Central Park was occupied by shanties, bone-boiling establishments, piggeries, and pools of offensive stagnant water which rendered the neighborhood anything but park-like. The first full year's report of the men who were given the work of turning this ground into a park, contains the following description of its condition:

"It was already a straggling suburb, when purchased by the city, and a suburb more filthy, squalid and disgusting can hardly be imagined. A considerable number of its inhabitants were engaged in occupations which are nuisances in the eyes of the law and forbidden to be carried on so near the city. They were accordingly followed at night in wretched hovels half hidden among the rocks.

"During the autumn of 1857, 300 dwellings were removed or demolished by the commisioners, together with several factories and numerous "swill milk and hog feeding establishments." Ten thousand loads of stone were also taken off the land and used to build a rough inclosing wall."

This description helps one to appreciate the vast amount of work, and artistic planning which has been necessary to bring the park to its present state of beauty and attractiveness, and it is interesting to see how fully the prophecy of a park commissioner, who wrote in 1868, has been fulfilled:

"But we who are in the middle of life," he says, "can never know all its beauty. That is reserved for those for whom we have planted these shrubs and trees, and spread these level lawns. These trees will arch over many happy generations, and thousands who are not yet born will enjoy the sweet green of the grass; and it will ever habitually serve to keep the memory of its founders green."

The central site was finally selected despite its unpromising topography, in preference to the one first proposed at Sixty-sixth Street on the East River—the Jones's Wood site—because it was central and spacious. It was also thought that the great expense of turning it into building lots—the extensive filling of low, swampy ground, and blasting away of ledges—would enable the city to purchase the land at a low figure. Including a number of acres of water surface, comprising the two reservoirs belonging to the Water Department, the cost was about $7,500 an acre. The total acreage, including the subsequent extension to 110th Street, was 843, and the price paid $6,348,959.90.

There has been spent in bringing the park to its present condition somewhere between $25,000,000 and $30,000,000.

The special committee appointed by the Board of Aldermen to select the most desirable park site pronounced emphatically in favor of "the Central Park," stating their opinion that "it could be made to compare favorably with the most celebrated public grounds of the chief cities of Europe, not excepting Hyde Park of London, the Champs Elysées of Paris, the Prater of Vienna, the Cascine of Florence, the Corso of Rome, the Prado of Madrid, or even on the American continent with the spacious plazas of Havana or the lovely botanical gardens of Rio de Janeiro.

It was freely predicted by the opponents of the park that it would prove a white elephant on the hands of the city; that it could never be made into a decent-looking park, and was an unnecessary extravagance which the city did not need and could not afford.

The largest settlement of the park seems to have been along the Eighth Avenue side. Mount St. Vincent was included within the park borders, situated just west of Fifth Avenue at 105th Street, on the old Boston post road, which ran diagonally through the park. The land and buildings (now the headquarters of Commissioner Wilcox), forming the State arsenal, were subsequently purchased by the city and added to the park in 1867, the price paid being $275,000.

Owing to the lack of funds no work was done in improving the land until 1857. In April of this year the legislature authorized the issuance of bonds and in the following June a tentative beginning was made on the park. Preliminary surveys had been carried out by Egbert L. Viele, the first engineer to the commissioners, but they soon decided that it would be desirable to offer a series of prizes to outside architects for designs for the formal laying out of the land. In 1857 such an announcement was made and on April 1, 1858, thirty designs were submitted. That of Messrs. Olmsted & Vaux was chosen, and they were awarded the first premium of $2,000. In 1857 Mr. Olmsted had been appointed superintendent to the board; George E. Waring, agricultural engineer; Samuel I. Gustin, nurseryman, and several other landscape offices had been created and filled.

In 1858 Mr. Olmsted was promoted to architect in chief at a salary of $2,500 a year, and the other offices abolished or subordinated to his.

The work of putting the successful design into execution was begun by Mr. Olmsted, Calvert Vaux, and J. W. Mould in June, 1858. The original plan has been pretty closely adhered to, during the forty-odd years of the park's existence, although there have been times when strong efforts were made to alter it, and even to remodel some of the previous work. In 1871 when the Central Park commissioners were legislated out of office, and a board of public parks for the whole city instituted, such an attempt was made, one of its features being an extensive thinning of the trees.

In the National Quarterly Review for March of that year Edward J. Sears, LL.D., made some interesting, because extremely personal, comments on the lethargy of the press in connection with the "vandalism" of the new park administration:

"Has the Times become indifferent to what was so dear to poor Mr. Raymond? Has Mr. Greeley no protest to make even as an agriculturist? Must the World remain dumb because he [Mr. Peter B. Sweeney, who was then president of the park board] is a very smart fellow at election time and carries the Irish vote in his pocket? No one has less excuse than the Express, for few visit the park more than Mr. Brooks and his handsome cream-colored ponies. He and Mr. Hastings would be much better occupied in exclaiming, 'Ringman, spare that tree,' than in going to law with each other. As to the Post, we fear it is too busily occupied eulogizing all books and pamphlets bearing the imprint of wealthy publishers."

Until 1871 the history of the park was an uneventful one. Most of the commissioners had served on the board since its first year, and except for family squabbles over the details of management and construction, the improvements were carried on without interruption practically in the entire charge of Mr. Olmsted. The difficulties which began to interfere with the efficiency of the department after its political organization in 1871 are indicated by the following extract from a pamphlet by Mr. Olmsted, who was subsequently made a commissioner and president of the board shortly prior to his dismissal:

"As superintendent of the park," he says, "I once received in six days more than 7,000 letters of advice as to appointments, nearly all from men in of-

fice." Delegations from various political organizations came to find out "what share of his patronage they could expect," and in order to make him as little trouble as possible in its parceling out "they took the liberty to suggest that there could be no more convenient way than that you should send us our due quota of tickets, if you please, sir, in this form, leaving us to fill in the name." Here a pack of printed tickets was produced, which proved to be blank appointments, bearing the signature of Mr. Tweed. "That," continued the spokesman of the delegation, "was the way we arranged it last year, and we don't think there can be anything better."

There seems to have been some misconception, during the early years of the park, as to its real purpose, and considerable jealousy of its regulations. In April, 1864, for instance, one of the regiments of the first division of the National Guard, despite the vehement opposition of the park keepers, marched through one of the gates and proceeded to drill upon the green. Another regiment subsequently attempted to do the same thing.

An interesting item in the report for 1863 is the announcement that fourteen European sparrows, "*moineau* of France," were let loose in the park in the spring of that year. This original fourteen, apparently the pilgrim fathers of the present local settlement, must now be represented by several million.

The paving of Fifth Avenue up to the park was completed in 1863. Previous to this, especially in wet weather, the approaches had been extremely bad, and the completion of the Fifth Avenue paving led to an immediate increase in the use of the park for driving. In its early days guards were stationed at each of the park gates, and a part of their duty was to count the number of persons passing in. In 1861 the result of the count was 1,863,263 pedestrians, 73,547 equestrians, and 467,849 carriages, the total number of visitors being estimated at 2,404,659.

"For the purpose of ascertaining the nature of the existing vegetation," says the first annual report (1857-58), "a botanical survey of the park has been made. First, to learn how far it can be made available in the projected improvements and to ascertain what plants will prove most flourishing if transplanted to this ground, and second to discover what alterations the soil will require in order to admit of an increased variety."

This report details about seventy species of trees, shrubs, and vines. Among the trees were included maples, beech, dogwood, chestnut, catalpa, red birch, persimmon, ash, locust, black walnut, red cedar, sweet gum, sycamore, poplar, American aspen, oak, and elm. All told, there were about 150,000 trees and shrubs.

Regarding the present vegetation there seems to be no available data, no continuous record of the planting having been kept nor any detailed botanical study of it made during recent years. Samuel Parsons, landscape architect for all the parks of the greater city, when questioned on the subject, said that such a botanical survey was desirable and would be extremely useful, and that he had on several occasions urged its preparation (he has been connected with the park for nearly twenty years). Mr. Wilcox, the present commissioner, is favorably inclined to the scheme, and it may soon be put into execution.

In connection with recent statements that the park is dying owing to the poorness of the soil, it is interesting to find that in 1859 Prof. Charles A. Joy, of Columbia College, made analyses of soil from various portions of the park. These are given in the following table, and while nowadays the agricultural chemist depends more on actual tests of what a given soil will grow than upon chemical laboratory analysis, Prof. Joy's figures will give some idea of the condition of the ground when first taken in hand by the park commissioners. The five samples were taken from the following locations:

No. 1. At Seventieth Street, near Fifth Avenue.

No. 2. Between Seventy-eighth and Seventy-ninth Streets, at Seventh Avenue.

No. 3. Between Eighty-third and Eighty-fourth Streets and Fifth and Sixth Avenues.

No. 4. Between 102d and 103d Streets and Fifth and Sixth Avenues.

" 5. At 104th Street, between Seventh and Eighth Avenues.

	1	2	3	4	5
Sand and mica	71.63	81.36	82.67	75.58	79.44
Water and organic matter	2.89	2.93	3.44	3.05	3.51
Soluble silica	4.58	3.51	1.79	5.86	3.56
Peroxide of iron	10.11	6.13	2.48	11.	10.
Alumina	6.4	3.80	5.42	3.25	1.25
Phosphoric acid	2.5	0.50	1.94	trace	0.08
Potash and traces of soda	0.1	0.87	0.45	0.35	1.25
Magnesia	0.08	trace	1.50	.50	0.07
Lime	1.25	0.15	trace	0.10	0.25
Sulphuric acid	0.10	0.50	trace	trace	0.31
Loss	0.27	0.25	0.31	0.31	0.28

The soil question is evidently an old one in the park. This one would naturally expect when the rocky, barren waste on which it was built is remembered.—Commercial Advertiser.

CONSUMPTION OF SUGAR.

THE people of the United States now consume eight times as much sugar per capita as they did in the first quarter of the last century, four times as much as the average per capita during the decade ending with 1850, and twice as much as they did in any year prior to 1870. In the years immediately prior to 1825 the average consumption of sugar was about 8 pounds per capita, in the decade 1840-50 about 16 pounds per capita, in the years immediately prior to 1870 the average was about 32 pounds per capita (omitting the war years, in which the consumption was light), from 1870 to 1880 it averaged about 40 pounds per capita, from 1880 to 1890 50 pounds per capita; in 1891 the figure was 66 pounds per capita, and has ranged from 62 to 68 pounds per capita since that time, the figure for 1901 being 68.4 pounds. This steady growth in the per capita consumption of sugar is shown by some figures which the Bureau of Statistics will present in the next issue of its annual volume, the Statistical Abstract. The per capita consumption has been a matter of record during recent years, but it has not been before practicable to compare the per capita consumption of recent years with that of earlier years, and to note the very rapid increase in the quantity consumed by each individual of the country.

This growth in the consumption of sugar is, evidently, not confined to the people of the United States. The increase seems to have been equally rapid in other parts of the world, judging from the figures of total production. Figures recently published by the Bureau of Statistics in its monograph, "The World's Sugar Production and Consumption," showed that the sugar production of the world was eight times as great in 1900 as in 1840, the figure for 1840 being 1,150,000 tons, and that for 1900, 8,800,000 tons. This increase in production, and consequently in consumption, has come largely through the development of the beet sugar industry, which increased from a production of 50,000 tons in 1840 to 200,000 tons in 1850, 831,000 tons in 1870, 1,402,000 tons in 1880, 3,633,000 tons in 1890, and 5,950,000 tons in 1900. During the same time, cane sugar production increased from 1,100,000 tons in 1840 to 2,850,000 tons in 1900. Beets in 1840 supplied 4.35 per cent of the total sugar product of the world; in 1850 they supplied 14.29 per cent; in 1860, 20.43 per cent; in 1870, 34.40 per cent; in 1890, 63.70 per cent; and in 1900, 67.71 per cent.

The per capita consumption of sugar in the United States is greater than that of any other country, except the United Kingdom, in which the annual consumption ranges from 85 to 91 pounds per capita, against 60 to 68 pounds in the United States, the figure of consumption for 1900 in the United Kingdom being 91.6 pounds per capita.

The following table shows the per capita consumption of sugar in the United States and the principal European countries in 1900, the latest available year:

Countries.	Sugar Consumption per Capita. Pounds.
United Kingdom	91.6
United States	65.2
Switzerland	60.3
Denmark	54.8
Sweden and Norway	38.2
France	37.0
Germany	33.9
Netherlands	32.5
Belgium	23.3
Austria-Hungary	17.6
Portugal and Madeira	14.7
Russia	14.0
Spain	10.6
Turkey	8.0
Roumania	7.8
Greece	7.2
Italy	6.1

THE THEORY OF THE GAS MANTLE.

A NUMBER of papers have been recently published which deal, either directly or indirectly, with the cause of the high efficiency of the incandescent gas mantle.* Space does not permit us to enter at all fully into the details of these papers, but it is of interest to consider some of the questions which they raise.

The high luminosity of the mantle and its still more remarkable dependence on a particular composition have long been recognized as facts calling for some special explanation, and many have been the hypotheses advanced to account for them. The simplest of these is that which regards the mantle's luminosity as an ordinary high temperature effect; as showing how the phenomena are accounted for by this explanation, we may quote the view put forward by Mr. J. Swinburne, Journal of Inst. Elect. Eng., vol. xxvii., p. 161. Mr. Swinburne will have nothing to do with selective emissivity, but states that "all bodies" (presumably solid bodies) "at the same temperature give out light of the same color." The Bunsen flame, he argues, in which the mantle is immersed, is extremely hot, and the mantle's luminosity is due to its very nearly attaining this temperature. A bad radiator (such as thoria) will reach the same temperature as the flame, but as it radiates so little energy, will give but little light; what light it does give, however, will be of high luminous efficiency. A good radiator (such as ceria) will radiate energy so fast that it will not attain anything like the flame's temperature. It is, therefore, only necessary to add sufficient ceria to the thoria to increase the emissivity enough to get a good quantity of radiated energy, but not enough to lower the temperature unduly, in order to get a composition giving a brilliantly luminous mantle. This explanation does not appear to us sufficient, especially when one considers that it is polished, and not white, bodies which are bad radiators, so that if it is legitimate to argue from their behavior at low temperature, thoria would be expected to be but little inferior as a radiator to ceria or even carbon. Also there seems some reason to think that selective emission is more probably the rule than the exception (see, for example, the work of Nichols and Blaker, published in the Physical Review).

Le Châtelier and also Nernst (loc. cit.) arrive at the same final result as Mr. Swinburne—namely, that the mantle is so bright because it more nearly approaches the temperature of the flame than any other body similarly placed—but by a different argument. The experiments which they made led them to conclude that the emissivity of the mantle is poor in the region of the red rays; hence there is little energy lost in non-luminous radiations, and the mantle can in consequence come up to the high temperature of the flame, at which it begins to radiate well, especially in the region from the green to the violet. The selective emissivity of the mantle material has therefore a double effect; it increases the luminosity at a given (high) temperature, and it enables the mantle to attain a higher temperature than a black body, because the total loss of energy by radiation is diminished. Bunte, on the other hand, claims that the assumption of selective emissivity is unnecessary, and that the mantle is at a higher temperature than the flame (Berichte Deut. Chem. Ges., 1898, i. 5). This view is supported by experiments he performed, in which different substances were raised to incandescence in pairs in the inside of an electrically heated tube; no appreciable difference could be observed in the light given by carbon, thoria, ceria, or the material of the mantles. It remains to be explained how the temperature of the mantle can be higher than that of the flame. This is due, he and Killing suggest, to the catalytic action of the ceria, which, by oscillating between a low and high state of oxidation, increases the rate of combustion at the mantle surface and so raises its temperature. The thoria is necessary, according to Killing, to give a large surface over which the ceria molecules are spread; and Bunte suggests that it also acts as an insulator between the ceria molecules, enabling them to maintain the high temperature that their catalytic action produces.

Obviously, the simplest method of testing the accuracy of some of these different hypotheses is to measure the temperatures of mantles of different composition. An attempt to do this has been made quite recently by Messrs. White, Russell, and Traver (loc. cit.). The temperatures were measured by means of small thermocouples, and (by making measurements with couples of different sizes and so obtaining data for extrapolation) they claim to have arrived at a method giving with considerable certainty the temperatures of flame and mantle. Even if the accuracy of the absolute values thus obtained be impugned, the relative results are not so subject to the same objections. These experimenters find that the temperature of the mantles and flame is from 1,500 deg. C. to 1,700 deg. C.; that the mantle is at a slightly lower temperature than the flame and at very nearly the same temperature whatever its composition; and, especially, that a pure thoria mantle is at a slightly higher temperature than one of thoria and ceria. Some actual results illustrating these points may be quoted from their paper:

Composition of mantle. Per cent.	Temperature of mantle. C.	Temperature of flame. C.	Candle power per sq. in.
100 thoria	1560°	1630°	3.8
99.5 thoria, 0.5 ceria	1520°	1630°	34.0

The mantles used are said to have been identical in every respect except in their chemical composition. The differences in temperature are not very great, but, such as they are, they do not harmonize with the theory of Le Châtelier and Nernst, since they show the thoria mantle to be the hotter; at the same time, they support this theory, as against that of Bunte by showing the mantle to be at a lower temperature than the flame. The results also support the views of Mr. Swinburne, which require that the order of the temperature should be the same as that observed. In some other experiments, the results were less conclusive, the illumination varying from 2.5 to 48 candles with practically no temperature difference. Mantles with a high percentage of ceria were not tested. The authors themselves conclude that the illumination is to a greater degree a specific function of the material than it is of the temperature, and that the particular thoria-ceria mixture is a solid solution capable of transforming the heat of the flame into light more economically than any other substance yet known.

If this explanation is to be accepted, the mechanism by which this transformation is effected remains to be explained. In that part of the paper by Prof. H. E. Armstrong (loc. cit.) which deals with the question of luminosity, we find a suggestion as to what this mechanism is. Prof. Armstrong's paper is of a comprehensive and far-reaching character, dealing with many things besides luminosity in general and that of the mantle in particular, but it is only its bearing on these questions that we can consider here. Prof. Armstrong thinks that "luminosity and line-spectra are the expressions—the visible signs—of the changes attending the formation of molecules from their atoms, or, speaking generally, *that they are consequences of chemical changes*." Applying this to the Welsbach mantle, after referring to Bunte's hypothesis, he says, "this undoubtedly must be the case; but I would go further, and regard *the chemical changes* occurring at the surface as the direct seat, or origin as it were, of the luminosity. Probably a higher oxide is alternately decomposed and reformed—in other words, *the process is one of oscillatory or recurrent oxidation*." This process, then, gives direct birth to the luminous radiations and accounts for the high efficiency of incandescent oxides generally, such as the lime and zirconia light and the Nernst glower. A somewhat similar conclusion is arrived at by Dr. Auer von Welsbach (loc. cit.), who considers that the ceria when in one or other state of oxidation can form a compound with the thoria; hence "if reduction takes place, there is also decomposition, and if oxidation, there is recombination of these elements; these reactions may go on several million times a second, and molecular shocks are produced which give rise to luminous oscillations of the ether, and the body becomes incandescent." Both Prof. Armstrong and Dr. Welsbach attribute the importance of the special composition of the mantle to this particular mixture forming a solid solution of a dilution favorable to the occurrence of the oscillatory changes.

We have endeavored to put forward a summary, of necessity brief, of some of the principal theories which have been advanced to account for the luminosity of the mantle. Although it is true that some of these theories, if regarded as individually sufficient to account for the phenomena, lead to conclusions mutually inconsistent, yet there is no reason why they should

* "Zur Theorie des Auerlichtes," by W. Nernst and E. Bose (Physikalische Zeitschrift, 1900, i. 289).
"Theory of the Incandescent Mantle," by A. H. White, H. Russell and A. F. Traver (Journal Gas Lighting), lxxvii, p. 879, and lxxix, p. 802).
"Theory of the Incandescent Mantle," by A. H. White and A. F. Traver (Journ. Soc. Chem. Industry, 1902, xxi, p. 1012).
"The Conditions Determinative of Chemical Change and of Electrical Conduction in Gases and on the Phenomena of Luminosity," by Prof. H. E. Armstrong, F.R.S. (The Chemical News, May 23 and 30, 1902).
"The History of the Invention of Incandescent Gas Lighting," by Auer von Welsbach (The Chemical News, May 30, 1902, p. 254).

not all contain some part of the truth, unless the experiments of Messrs. White, Russell, and Traver be considered as sufficiently conclusive against the idea of the mantle being hotter than the flame. Such a result does not preclude the possibility of catalytic action, for the additional energy thereby developed may be all dissipated in luminous radiations. It seems that the most satisfactory explanation that the present experimental data justify is that the high luminosity is due to a combination of the good radiating power, the high temperature and the selective emissivity of the mantle. The first accounts for the high candle-power at the temperature attained; the second, which is due partly to the selective emissivity diminishing the useless radiation losses and partly, no doubt, to the catalytic action of the ceria molecules, is responsible for the high luminous efficiency of the light, so far as this is a function of the temperature; while the third, most probably due to the recurrent chemical changes, accounts for the high luminous efficiency so far as it is a function of the material. Thus all these causes, operating together and assisting one another, combine to produce one of the most efficient artificial illuminants that the ingenuity of man has devised.—Maurice Solomon in Nature.

ANALYSIS OF CERTAIN ANCIENT METALLIC OBJECTS.*

By M. BERTHELOT.

THESE objects proceed from the collection of the Louvre, and particularly from hieratic statuettes. They have been perforated at the base to allow them to be fixed on a pedestal and have thus furnished a quantity of powder, which M. Heuzey has asked me to analyze.

I. Statuette representing a woman sustaining with her arms a basket on her head. She is about twenty centimeters high and bare to the waist, but the lower part of the body is clothed with a sort of skirt covered with inscriptions. There are no lower limbs, the body terminating in a point. This image is of a type usual from the time of Goudeah until that of King Rim-Sin, a period of twenty centuries.

The figures of this class played the rôle of amulets, and were buried in the foundations of edifices. The present statuette is dated in the time of Bour-Sin, the Chaldean king of the city of Our, about the 26th century before our era.

It is of copper-red color. All the parts of the body are covered with a double patina, one superficial, greenish, and worn off in places, the other deeper and more uniform, and of reddish color.

Three distinct analyses of the metal have been made. The first was of a powder extracted at 35 mm. of depth from the vertical axis. This powder presented the appearance of a reddish-white metal. It contained in 100 parts, copper, 76 p. c.; lead, 18 p. c.; sulphur, iron, oxygen, etc., 5 p. c.; no tin, zinc, arsenic, or antimony was found.

This composition having surprised me, I detached from the back of the statuette a compact fragment, distinctly red, which was submitted to a special analysis (two determinations). In 100 parts there were copper 77.4, lead 17.1, sulphur 2.3; with a little iron, but no tin, zinc, antimony, or arsenic. This analysis confirmed the first, except a slight excess of lead in the interior, attributable to a commencement of liquation.

The patina contained carbonate of copper and oxides of lead and iron.

Thus the present statuette consists principally of an alloy of one part of lead, with somewhat more than four parts of copper, and a marked percentage of sulphur, proceeding without doubt from the ore which served for the production of the metals.

This composition contrasts with that of the ancient statuettes of Goudeah and of Our-Nina, which consist of almost pure copper. It does not differ less from that of the statuette of the time of Rim-Sin, of date 2,200 years before our era, also formed of nearly pure copper.

This circumstance having caused some doubt in my mind, I repeated the analysis on a sample of powder extracted from the center of the statue, and consequently containing no patina. These are the results: copper, 95.7 p. c.; iron, 3.1 p.c.; sulphur and oxygen, 1.2 p. c.; no tin, lead, zinc, antimony, or arsenic.

II. Babylonian statuette of unknown date. Height, 122 mm. It represents a bearded priest, or a divinity, with a tiara on his head, and holding an animal on his breast; reddish metal; powder mixed with carbonate of lime.

The oxygen was determined in the form of water by heating the material in a current of hydrogen. There was no lead, zinc, antimony, or arsenic; copper, 79.5 p. c.; tin, 1.25 p. c.; iron, 0.8; oxygen, 9.75; carbonate of lime, 8.3 p. c. The metal was strongly oxidized.

III. Pedestal of a small Babylonian bull, having the appearance of bronze, with silver incrustations. There was no opportunity to analyze the statue. That of the pedestal yielded copper, 82.4 p. c.; tin, 11.9 p. c.; iron, 4.1 p. c.; oxygen and gloss, 1.6 p. c. There was no lead, antimony, zinc, or arsenic. This metal is an ordinary bronze, with a material percentage of iron.

It is seen that the composition of the alloys, under the same appearance of red metal, presents great diversity, for a period later than the year 3,000 before our era. I have already made the same remark with reference to the Egyptian metals.

This diversity results in part from the nature of the ore, but the additions of lead and tin were intentional.

IV. Hittite seal, formed of white metal (from the Louvre). It is of silver, with traces of copper and iron.

V. Matter proceeding from the necropolis of Abou-Roash of the fourth Egyptian dynasty. It was sent to me by the French Institute of Oriental Archæology of Cairo as containing silver. I separated it into two parcels, according to the appearance, the object being without shape.

1. The darkest and less friable matter: Pb, 28.93; Cl, 6.81; O, 0.70; CO_2, 1.93; SiO_2, 51.27; Al_2O_3, water, CO_3Ca, 10.36; no silver or copper.

2. Matter less dark more friable: Pb, 22.20; Cl, 5.86; O, 0.40; CO_2, 1.16; SiO_2, 56.96; Al_2O_3, 8.94; CO_3Ca, water, 4.48. It is a mixture of clay, with lead chloride, containing about a quarter of carbonate, and proceeding undoubtedly from the change of an object of lead which has remained for centuries in brackish water containing chlorides. These salts accelerate and determine the oxidation of metals, such as iron, copper, lead, and silver, which are changed slowly into chlorides, oxychlorides, or oxides, according to the difference of conditions.

In certain cases the presence of a trace of chloride is sufficient to determine in the collections of the museums the progressive disaggregation and destruction of the objects of copper and lead, which seem to be attacked with a sort of efflorescence and apparent moldiness, as the conservators are aware. I have reproduced these results in my laboratory, and have already given the theory of them.

* Memoir presented to the Académie des Sciences.

SEA TEMPERATURE AND SHORE CLIMATE.

THE actual influence of our Great Lakes on the climate of stations on the windward side is appreciable by the increased cloudiness twenty miles from the shore, but not much beyond; its influence on the temperature is only appreciable by the prevention of early frosts by reason of the formation of cloud and fog. The general influence of the Atlantic Ocean on the weather of Great Britain, or of the Pacific Ocean on the weather of northern California, Oregon, and Washington is to produce cloud, fog and rain and thus affect the temperature indirectly. The direct effect of a rise or fall in the temperature of the ocean surface is analogous to the direct effect of the changes in the temperature of a land surface. Both should be expressible by an algebraic formula, consisting essentially of two terms, viz.: (1) a term expressing the heat given back to the air by conduction and convection and radiation, all of which, of course, is much larger by daytime and smaller by nighttime for the land as compared to the ocean, and (2) a second term expressing the quantity of latent heat conveyed to the air by the evaporation of moisture, which on the average of the day and night is greater for the ocean than for the land. But when the lower layers of air thus warmed and moistened have moved to a great distance horizontally or vertically, or when, without much motion, this air is cooled down by radiation, then the land air keeps clear longer than the ocean air and it is this property that produces the great variety of climates to the leeward of the water.

The general character of the weather is controlled principally by the vertical ascent or descent of the wind and by its northern or southern direction much more than by the fact that it blows from the ocean. All winds that come from the Pacific have sufficient moisture to form rain and prevent the occurrence of either extremely hot or extremely cold weather, provided only they can be forced to rise up and be cooled dynamically or blow northward and be cooled by radiation. Both these causes conspire to form the winter rains on the Pacific coast north of latitude 40 deg., and also in Great Britain north of latitude 50 deg., but neither of them contributes to the formation of rain at any time of the ordinary year south of San Francisco, Cal., latitude 38 deg.—Prof. Cleveland Abbe, in the Monthly Weather Review.

THE COLORS OF STARS.

"THE wide difference which there is between star and star as to brightness," says Mr. E. Walter Maunder, F. R. A. S., in Knowledge, "is apparent on the very first glance toward the heavens; it requires a more careful scrutiny to realize that they differ also in their color, and in the character of their shining. The ancients carried their discrimination of the difference of the brightness of stars so far as to recognize six magnitudes, but when it came to the question of color they hardly noted any differences at all. The stars in general were described as yellow, six only being recorded as 'fiery.' Of these six we should class five as being distinctly orange or red—Antares, Betelgeuse, Aldebaran, Arcturus and Pollux. The sixth, Sirius, is to us an intensely white star, and there have been many discussions as to whether it has changed its color in the last 2,000 years, or whether the description given of it—'fiery red'—is due to some mistake in the record, or whether the excessive scintillation of the star may account for it. For, as we see it now when near the horizon, a momentary flash of vivid red flame shoots out from time to time, due to the irregular dispersion of its light in passing through the tremulous atmosphere. It is from this that Tennyson, most exact of all the poets in his scientific references, calls Sirius 'fiery' in the well-known passage from the 'Princess':

'The fiery Sirius alters hue
And bickers into red and emerald.'

Assuming that the light of any star is partly white and partly colored, we may divide the stars into classes, depending entirely upon the depth of tint which they show, and not upon its color. A five-fold division suggests itself, something to the following effect: (1) pure white, (2) tinted, (3) colored, (4) fully colored, (5) deeply colored. After the question of the depth of tint which the stars show, comes the question of the color of that tint. For naked-eye stars, the more refrangible colors do not come into consideration. The range is from orange-red up to yellowish green, or possibly in a single instance—that of Beta Libræ—to green. Alpha Lyræ, and possibly one or two other stars, have a distinct bluish tinge, but in general the stars not passed as white may be very well scheduled under one of the five following heads: (1) reddish-orange, (2) orange, (3) orange-yellow, (4) yellow, (5) yellowish green. In working upon star colors with the naked eye it is impossible to use any artificial standard of color, but the wide field of view, and the ease and rapidity with which the attention can be turned from one part of the heavens to the other, will much more than make up for this deficiency. The stars must be compared one with another, the estimations of color must be purely relative, and the method will be found much the most accurate possible."

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Opening for Well-boring Machines in China.—The city of Nankin, though the southern capital of China, does not possess a waterworks system. Foreigners of various nationalities are trying to secure the franchise, but the conditions specified seem to be such that the authorities do not care to comply with them.

The season has been an unusually dry one and the question of a water supply has been agitated. Many foreigners have been compelled to hire carriers to bring water from the Yangtze for drinking purposes, but they can never be sure it is not taken from some filthy creek. When about to move into the new consulate building, I resolved, if possible, to secure a well free from surface drainage and containing pure water. With that end in view, I had made (from drawings) a "drive point," and proceeded to "drive" a well as it is often done in certain localities in the United States. At 30 feet (about 4 feet below low-water wark in the Yangtze) I found a strata of sand with an apparently inexhaustible supply of clear, pure water. The "American well," as it is called, soon attracted the attention of high officials living in the city, who one after another came to see and test it. The result of their investigations was the setting apart of an amount of money to be used in securing like wells about the city, to the number of one hundred. The fantai, a man next in rank to the viceroy, came at the viceroy's request and asked me to aid them in the work. Tests showed that the soil was adapted for the wells only here and there, and I therefore advised against the expenditure and suggested artesian wells, with storage for fire purposes, as preferable.

The advice has not yet been acted upon, but the reputation of the American well has spread until from different parts of the province, as well as from Ningpo and Tsingkaing, come requests for my aid in securing a good supply of water by pumps.

I believe there is a good opening in China for a few persons who understand sinking artesian wells and other methods of securing a good supply of pure water. Waterworks are unknown in China outside of foreign concessions.

There came to this consulate the other day, accompanied by the taotai of foreign affairs in this city, a Mr. Chang Ching (known as the "Optimus" of China—that is, the man who passed the highest rank in the highest examinations), who said he was much interested in deep-well work, and that he had organized a company, which had purchased over 1,000 acres of land with the intention of utilizing it for cotton raising and other agriculture. He wishes to know about American machines for diking, deep-well boring, and windmills. If manufacturers of these machines will send to this consulate catalogues with prices and probable freight cost of their various products from New York to Shanghai, I will see that they are put where they will do the most good. The prices required are the net ones to the purchaser.—William Martin, Consul at Nankin.

Proposed Currency Changes in Indo-China.—Mr. Paul Leroy Beaulieu, the eminent political economist, has published an article in which he recommends that the government of France make a monetary change in the coin used in Indo-China, similar to that made by the British government in India in 1893. He shows that the piaster of that colony, which ten years ago was worth 5 francs (96 cents), has fallen with the decline of silver until it is now worth less than half that sum. He advises that its value be placed at 50 cents. This is about 25 per cent. more than its current value, but he thinks that with the cessation of coinage and the increase of population and business, it can be maintained at that figure. He asserts that during the last few years Indo-China has been inundated with Mexican coins. He advises that hereafter such coins should be outlawed and that all the piasters of the country of domestic or foreign origin should be recast in 50-cent pieces.

The finances of India are regarded as being on a gold basis, with the silver rupee as the unit of value, representing one-fifteenth part of the gold contained in the sovereign. A gold reserve of some £9,000,000 ($43,800,000) is held for the purpose of keeping the rupee at par with gold. It is altogether probable that the proposal of Mr. Beaulieu in regard to the finance of Indo-China will be adopted by the French government, but he does not propose a gold reserve.—John C. Covert, Consul at Lyons.

American Shoes in Jamaica.—Consul G. H. Bridgman, of Kingston, January 30, 1903, reports that the trade in American boots and shoes has increased so much of late that the matter became one of government inquiry, and the result shows that the apparent causes of the improvement in this trade are: (1) Quicker and cheaper transit of goods from the United States; (2) excessive charges made by the British manufacturers for cases; (3) greater suitability of American lines for the Jamaica trade and better attention given to the appearance of the goods, especially in the cheaper grades; (4) quicker dispatch by American manufacturers in executing orders.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

Solubility of Various Substances in Glycerine.—

	Per cent.
Acetate of copper	10
Acetate of lead	20
Acid, arsenious	20
Acid, arsenic	20
Acid, oxalic	15
Acid, tannic	50
Arseniate of potash	50.5
Arseniate of soda	50
Bicarbonate of soda	8
Bisulphate of alumina and of potash	40
Bromide of potassium	25
Carbonate of ammonia	20
Carbonate of soda	98
Chlorate of potash	8
Chlorate of soda	20
Chloride of ammonia	10
Chloride of barium	10
Chloride of mercury	7.5
Chloride of zinc	50
Iodine	1.9
Sulphate of copper	30
Sulphate of iron	25
Sulphate of zinc	35
Sulphur	0.1
Sulphide of calcium	5

—Les Corps Gras Industriels.

Waterproofing Blue Prints.—A simple and inexpensive method of waterproofing the prints which renders them completely impervious to weather and water is given in Mines and Minerals. The waterproofing medium is refined paraffin, and may be applied by immersing the print in the melted wax, or more conveniently as follows: Immerse in melted paraffin until saturated a number of pieces of an absorbent cloth a foot or more square, and when withdrawn and cooled they are ready for use at any time. To apply to a blue print, spread one of the saturated cloths on a smooth surface, place the dry print on it with a second waxed cloth on top, and iron with a moderately hot flatiron. The paper immediately absorbs paraffin until saturated and becomes translucent and highly waterproofed. The lines of the print are intensified by the process, and there is no shrinking or distortion. As the wax is withdrawn from the cloths, more can be added by melting small pieces directly under the iron.

By immersing the print in a bath of melted paraffin the process is hastened, but the ironing is necessary to remove the surplus wax from the surface, unless the paper is to be directly exposed to the weather and not to be handled. The irons can be heated in most offices by gas or over a lamp, and a supply of saturated cloths obviates the necessity of the bath.

This process, which was originally applied to blue prints to be carried by the engineer corps in wet mines, is equally applicable to any kind of paper, and is convenient for waterproofing typewritten or other notices to be posted up and exposed to the weather.—Drug. Circ. and Chem. Gaz.

A New Insulating Varnish Called Rusolite.—Messrs. Frischauer & Co., chemists of Vienna, have produced a new insulating varnish capable of resisting not only elevated tensions, but the action of heat, moisture and acids.

The new varnish, to which the name "rusolite" has been given, is said to possess the following properties: It is a bad conductor of heat; it supports a temperature of 325 deg. C.; when dried, it remains insoluble in presence of all chemical agents; it is easily applied to all kinds of bodies; it does not crack; and finally it yields a brilliant covering having the appearance of enamel. The resistance to heat is particularly important; for in the case of an excessive charge of electrical apparatus, and especially in the case of strong heating, this varnish avoids the usual risks. The insulating power of "rusolite" is enormous. Experiments made at the Technological Museum of Vienna have demonstrated that a coating of 6 millimeters in thickness melts only under the action of an alternating current of from 5,300 to 6,200 volts, and that a leaf of paper covered with the varnish resists an alternating current of from 4,000 to 5,100 volts. The new varnish will find a particularly advantageous employment on dynamo machines, on the coils of transformers, on the wires of storage cells, in moist places or subjected to acid vapors. It remains flexible without losing its insulating power.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT, from the Moniteur de l'Industrie et de Batiment.

To Harden Plaster of Paris.—I. Mix with the plaster 2 to 4 per cent. of powdered marshmallow root and form the paste with 40 per cent. of water. After an hour the mass is so hard that it may be filed, cut, or bored; an addition of 8 per cent. marshmallow root powder makes it thicker. Marshmallow root powder may be replaced by dextrin, gum arabic or glue.

II. Mix 6 parts of plaster and 1 part of slaked lime and moisten with a concentrated solution of magnesium sulphate.

III. Digest the plaster with 10 per cent. solution of alum, and calcine. On the addition of water the plaster hardens to a marble-like mass.

—Drug. Circ. and Chem. Gaz.

To Oxidize Silver.—The "oxidation" of silver is a very simple operation, still there is some little skill necessarily involved in putting a handsome black finish on the object after treatment. The Journal der Goldschmiedekunst gives the following directions, by following which, very fine effects may always be obtained. Into a cup of hot water put about ten grains of liver of sulphur (potassium sulphide) and mix well. Into this plunge the object to be colored, after first making it as white as possible with the scratch brush, and let it remain there for about two minutes. Take it out, then rinse it with clear water, use the scratch brush on it again, and return it to the still warm bath. Let remain for a similar length of time, then repeat the operation of scratching off and returning to the bath. A third immersion is usually sufficient to produce a wonderfully fine black "oxidation."

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